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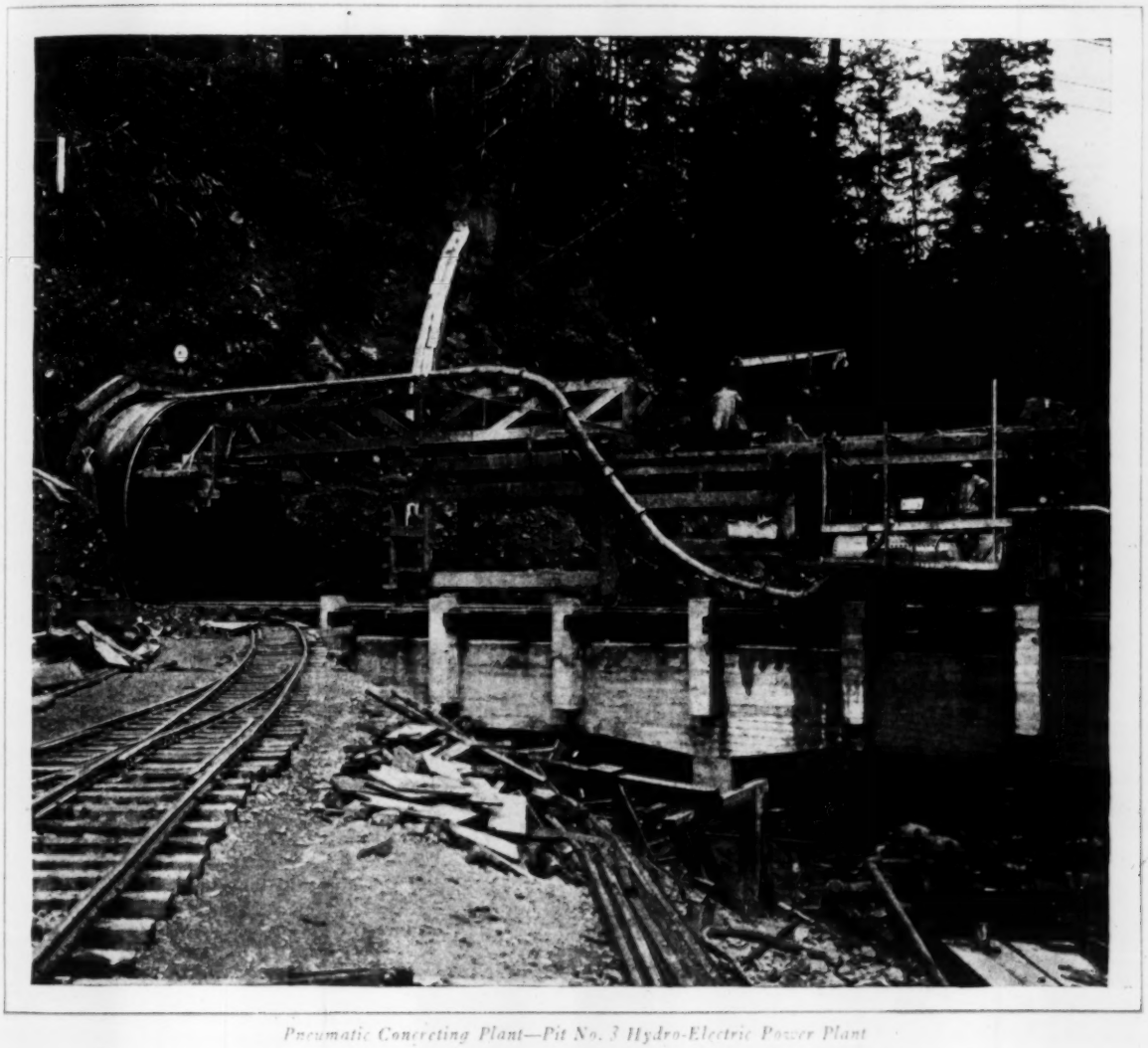

Pneumatic Concreting Plant—Pit No. 3 Hydro-Electric Power Plant

Placing Lining in Pit No. 3 Tunnel with Pneumatic Concrete Guns

California Land Settlement at Delhi

Repair Costs of Asphalt Pavement

Chicago's New Produce Market

Plant of the Rundle Manufacturing Company, Milwaukee. Hopp, Paterson Company, Architects. Covered with Federal flat and channel slabs. Circle shows interior. Note how channel slabs rest directly on steel structure.

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ENGINEERING NEWS-RECORD

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 95 NEW YORK, JULY 23, 1925 Number 4

Federal Aid Expenditures

ANOTHER fiscal year has closed in the accounts of the United States for federal aid for public roads. The customary monthly report of the Bureau of Public Roads for June is therefore of interest as a balancing of accounts. Since 1917 the United States has contributed for public roads completed, under construction and approved for construction a total of $517,895,146. This aid has been contributed to 61,117 miles of road whose total cost, determined or estimated, is given as $1,182,673,290. This is $8,473 of federal expenditure per mile of road aided. These are stupendous figures. In opposition there stand the figures of tax receipts from motor vehicles. In 1924 they amounted to $555,028,548. Now, when federal aid for public roads is being more severely questioned than for some time past, engineers need to keep all the figures in mind.

Baltimore Centralizes Engineering Service

BALTIMORE has taken a long step forward in centralizing its engineering services in a single department, headed by a chief engineer under whom there are various bureaus, also headed each by one engineer. The plan has not been carelessly framed or hastily adopted. It was worked out by a special Committee on Economy and Efficiency, submitted to the public and for weeks past has been the subject of public hearings and discussion in the press. The city council finally adopted it with little or no material change, we understand, although proposals to weaken it were made. Mayor Jackson, in the appointments announced elsewhere in this issue, has chosen men already in the city service, some for many useful years. Many there are who will feel that Baltimore would be better off if it had gone beyond mere centralization and removed the new department further than it is now from politics. As it is, the department chiefs and bureau chiefs, at least, are appointed by the mayor and confirmed by the council, retaining the old combination of powers, and not giving the head of the department choice of his bureau chiefs. Even so, most of those who believe in separating the executive and legislation functions will agree that the change introduced at Baltimore is good as far as it goes.

Contractors' Ethics

LIKE snakes in Ireland, contractors' ethics has commonly been held to be conspicuous by its absence. As a fact, lack of ethics has never been more true of contractors than of others but theirs is a highly competitive business and one of almost the least profit of any business of which the Government reports statistics, so if they therefore have been tempted into close dealing on occasion the fact is not miraculous. On more than one occasion, as court decisions have shown, the professional engineer has not been above dealing to the contractor from the bottom of the pack. Recrimination, however, gets neither ethics nor profitable trade to any desirable position and this occasion of reverting to conditions is taken merely because of the propaganda for ethical practices being pushed by the Associated General Contractors. They modestly call their statement rules of ethical practice instead of a code of ethics but the meaning and intent are the same. The rules as printed elsewhere in this issue are worth reading. They indicate a feeling of responsibility to the public quite as high on the part of contractors as that expressed by any other business or profession either by word or action. In the matter of ethics as in that of responsibility, which is another contractors' problem, definition that all will agree upon is difficult. Both have elements which transcend definition and rules. It helps, however, to have some measuring device and, as do the questionnaires and financial statement for bidders help to measure responsibility, so will the rules of ethical practice now being sent out help to advance fair dealing. Each engineer and architect is urged to see what part it is expected he can play in this code.

Delhi Retrieved

FOR something more than a year California state affairs have been agitated with discussion of the unhappy condition of the Delhi farm colony, which with the slightly older and very successful Durham colony constituted the state's venture into the field of planned land-settlement. Continued complaints by some of the Delhi settlers, followed by repeated sharp criticisms and vehement denunciations of the colony and its progenitors on the part of the governor of the state, made the case perplexing. The undertaking was the state's own venture, and the motives as well as the methods embodied in it appeared as unselfish and helpful as those of the federal land bank system. Yet the complaints and criticisms indicated some major disease. The entire conception of planned and aided settlement seemed to be under indictment—a condition that was the more regrettable because at many other places in the West the contrary system, go-as-you-please settlement, had failed conspicuously. The known facts in the case were confusing and did not reveal the nature of the trouble. It seemed likely that the agricultural depression beginning with the 1920 deflation had its effect here as elsewhere in the irrigated West. The state administration having changed, political animosities and intrigues might be partly to blame. A certain amount of plain, ordinary repudiation spirit appeared to be involved—the fatal poison weed of a few of the federal reclamation projects, a weed which thrives on politics. Nevertheless it was possible that the planned-settlement idea had proved a definite failure here, because of inherent faults. To give clearness under

these obscuring circumstances, Nathan A. Bowers, of the staff of *Engineering News-Record*, undertook a personal study of the matter. His analysis and conclusions appear on p. 143 of this issue. Though stated briefly and considerately, they constitute a remarkably clear picture of the whole enterprise and point out weak spots in its execution that brought about the recent troubles. In sum, however, they are a thorough defense of the conception of planned settlement represented at Durham and Delhi, and a vindication of Elwood Mead and George C. Kreutzer, whose practical idealism was the driving force of the venture. And, best of all, they forecast that now, with the new support of the state, Delhi is on the way to working out its troubles and proclaiming success.

Pavement Service Records

A RECORD of pavement maintenance costs, including every pavement constructed in 37 years, is by the least estimate a noteworthy document. Indeed we venture to think that few cities can exhibit such a record. Be this so or not so, the record summarized in this issue by the city engineer of Columbus, Ohio, has seldom been equalled among service accountings of one type of pavement which have appeared in engineering literature. Mr. Simpson deserves the thanks of every road engineer for his work. It has been a tedious task to delve into all the accounts for a generation, of over 300 separate improvements. We have known the work in its doing and speak with knowledge of time and detail. The results are spread out so clearly in the article that engineers may determine for themselves their value.

Air-Placed Concrete

FEW methods of doing work have been more fought over than placing and mixing concrete by air pressure. For a dozen years the courts have been importuned by complaint and defense in respect to one claim or another. Perhaps the conflict is older for now no one except the contestants and their council makes pretense of knowing the situation. Indeed it is only of indirect interest to users where the rights of invention lie. What is of chief concern is that by constant bickering at law the development of a highly useful method of conveying and depositing concrete has been hampered. This conviction is forced by the experience described in this issue in lining the Pit No. 3 tunnel with concrete placed by air. Here is an example of the almost supreme merits of air placing in tunnel lining under certain conditions. There are previous examples, some equally and some less convincing but all showing possible high usefulness for the method. Yet today it is a method that is rather commonly dodged by tunnel builders. Partly no doubt this condition is due to dislike of buying a law suit with every placing outfit, but it comes far more from the fact that patent rights disputes have prevented any opportunity for strong commercial promotion and improvement. The situation needs remedy. Incidentally, it may be noted that in the Pit No. 3 tunnel and also in the Queensborough subway, separated by the width of a continent, compressed air was used for placing pre-mixed concrete and not as a combination mixing and placing process as employed for example in some of the Chicago waterworks and river tunnels.

Earthquake Hazards

EARTHQUAKE matters are much to the fore at present. Apprehension has grown up, especially since the Santa Barbara visitation, over the possibilities of similar destruction elsewhere, in regions thought to be permanently quiet. And rightly so. Only the very short period of New-World history and tradition is available to us as a criterion of earthquake possibilities, and this is but a minute span in the earth's cycles. But our imagination readily pictures the horror that would surround the shaking to pieces of one of our skyscraper cities by a great earthquake, and we are unwilling to face the prospect.

Time was when the only forethought on earthquakes was that they would come when they might and destroy what they would. We are not content with such resigned fatalism today; we prefer some definite outlook to a blind waiting for future happenings. Our courage as well as our fears have grown; our fears, because we realize how vast are the potentialities of destruction in the crowded and highly complex city life of today; our courage, because San Francisco, Tokyo and now Santa Barbara have shown that man's constructions can withstand the earthquake's shock, if rightly built. It is therefore accepted that those who build in the California or Japanese earthquake districts, and elsewhere in the unquiet circum-Pacific belt, should build with careful calculation to resist earthquake forces of certain definite intensities. Courage and fear now lead to the further question whether the same precaution should apply at Chicago and St. Louis, or Boston, or Washington. Shall we count on the possibility of earthquake shocks there and protect against their effects? We have the choice between waiting until an earthquake does visit these regions—if ever—and discounting that prospect by providing now some moderate degree of protection.

Unfortunately, it is not practicable to appeal the question to cold reason; knowledge is inadequate. Judgment, with only a trifling guidance of reasoning, must make the decision. The scientific men, geologists and seismologists, are unable to decide the case. They do not know what causes earthquakes and cannot reduce them to cycles or systems. As Josiah E. Spurr, noted student of geology and of ore-deposit formation, said editorially in *Engineering and Mining Journal-Press* two weeks ago, in pointing out that the current fault-slip theory lacks proof, "The fact is that earthquakes cannot be foretold as eclipses can be. The public expects the geologist to do this; and the geologist is prone to seize the opportunity. But it is altogether probable that they will never be foretellable—until after the event, as now"; the last passage refers, perhaps, to miscellaneous claims of prediction which newspaper interviewers have extracted from this and that geologist since the shocks of June 29.

To paraphrase Mr. Spurr's terse dictum: it is not possible to predict when and how violently a new earthquake will shake Tokyo or Santa Barbara, and it is not possible to tell when, if ever, an earthquake will disturb New York or St. Louis. The question of whether it is wise to provide protection remains one for practical judgment, as we have said; and practical judgment reckons with chances and with costs more than with theories or rules. Practical judgment—a high type—builds fire-resisting structures not because fire has come or will come but because it *may* come;

and because the cost burden of providing protection is small compared with the burden of the risk.

Some few data are available to guide in forming a judgment on earthquake hazards, fortunately. It is known from relatively recent experiences that buildings can be made strong enough to resist even violent earthquakes. It is also known (somewhat less definitely, but much supported by the experience of Santa Barbara) that the cost of providing protection against moderate earthquakes is not great. In fact—and this is of great importance, we think—high-grade city buildings have almost as much strength as needed to resist even fairly violent earthquakes (*vide* Tokyo), and if their structure is studied and detailed throughout from the earthquake viewpoint in addition to the conventional load-and-wind viewpoint, little or no extra cost need be incurred to obtain a very high degree of security.

It is of only partial avail, of course, to assure the survival of a building's skeleton, if we allow cornices to be thrown down, walls shaken out, and both street and interior to be made a ruin heap. Attention must be given to all elements of the building, in other words, if the security is to be real. Foundations must be tied together, framework made stiff enough to carry the lateral shock pressures, walls fitted and proportioned to the framework, and all the minor parts bonded in so thoroughly that they cannot be shaken loose or be broken by concentration of the whole great force on a weak but rigid element. These principles are gradually being brought out into clear view and understanding; Mr. Dewell contributes largely to this end in his article in this issue. But these requirements do not change the fact that such thorough provision of resistance does not cost a great deal. The structures at Santa Barbara, at least, devoid apparently of all special planning for strength against earthquake shock, failed many of them only in a few local weak spots, whose strengthening would have cost fewer thousands than the earthquake loss in millions.

We have the one datum, then, that earthquake protection is possible, and that its cost need not be great. On the other hand, in the matter of the risk to be feared we are thrown back on the most slender inferences.

The facts at hand are few, but they appear significant. The delicate records of seismographs have shown during many years' observations that earth tremors occur everywhere on the surface of the globe, though vastly more often in the recognized quake regions than elsewhere; these tremors are earthquakes, just as the larger ones that are felt by the senses. The facts as already known, then, compel a belief that seismicity is universal, and that quiet regions no less than such zones as the Pacific belt are earthquake regions.

Thus, the question is not whether Chicago or New York has an earthquake hazard, but rather how great is this hazard—how long one's foresight should be; whether the hazard should be rated negligibly small, and therefore simply ignored, or whether definite protection should be planned. And in the latter case, what strength of shock should be kept in mind when providing structural protection.

We are inclined to believe that the most feasible method is to proportion the protection to the degree of seismic activity of the region as gaged by the frequency and strength of the earth movements revealed by seismographs. Such a method of inference will lead to quite modest estimates of earthquake force to be resisted in normal regions. Where conditions in the most active parts of Japan call for resistance to forces as large as 10 to 20 per cent of gravity, conditions in most parts of the United States would probably justify only one or two per cent resistance, the higher figure, perhaps, because the extent of possible damage is a factor to be considered. These small force requirements make the problem of protection to buildings relatively simple. It reduces for the most part to a matter of taking definite account of such lateral force in every part of a structure and under all the conditions that may prevail during a shock. This done, however, assurance would be had—were it possible to extend the protection to all buildings—that the hazard of earthquakes in great modern city communities has been substantially removed.

Full-Time County Health Officers

THE number of counties which now have full-time health officers is encouraging. True, the list recently published in *Public Health Reports* totals only 267, or less than 8 per cent of the 3,065 counties included in the 1920 Census, but this is a great gain over a few years ago and gives hope for further progress.

It does not necessarily follow that states with few or even no full-time county health officers are backward in public health work. Judgment on this point must be based on knowledge of methods of local health administration. Thus, Massachusetts and New York have only one officer each in the list, and New Jersey and Pennsylvania have none but no one well informed in these matters would say that these states as a whole are neglectful of the public health—however true this may be of their rural districts. In New England, the county functions but little outside of the administration of justice, whereas in most of the Southern States the county, outside the cities, is the chief or sole local government agent. Counties in New York, New Jersey and many other states have quite extensive governmental functions, but these do not extend to health matters. How much these local differences go along with the well known 48 varieties of government of our 48 states is illustrated by Ohio, where although municipalities are numerous and strong and the county not so all-powerful locally as in the South, more than half the counties (47 of 88) have full-time health officers.

No matter how long maintained and how strongly defended are the traditions for local self-government, and there is much to be said for them, the fact should be faced that in some parts of the country health protective needs have far outrun the organization and capacity of many of the existing minor civil divisions. The towns, townships and boroughs of the Northeast, the towns and numerous small not to say tiny cities of the Central West, Southwest and Far West need administrative health units with larger financial and administrative resources than the governmental units just named possess. But it does not follow that in every state these larger units should be the counties. In some populous sections it would be wiser either to have two or more of the smaller incorporated places unite with adjacent rural areas, or else several of the rural towns or townships might well join in public health work directed by a competent full-time health officer. In some cases, there might be several of these joint health units in one county.

Lining Pit No. 3 Tunnel Using Pneumatic Concrete Guns

Schedule Arranged to Operate Four Guns Without Interference, Each Able to Place 210 Cu.Yd. per Shift —Novel Details in Locating and Placing Reinforcing Steel and Concrete Forms

RAPID progress was sought in placing concrete lining in the 4-mile tunnel of the Pit No. 3 hydro-electric project of the Pacific Gas & Electric Co. in northern California because other parts of the development were nearing completion at the same time and the tunnel was needed for service. Lining operations were therefore laid out on a basis to permit the use of four guns and a fifth was added toward the end of the job. After working out refinements in methods and equipment it was found possible to place concrete in the arch at the rate of 70 lin.ft. (210 cu.yd.) per gun per shift.

The finished tunnel is circular in section, 19 ft. in diameter inside with a minimum concrete thickness of 8½ in. in front of timbers, 12 in. in the invert and an overall average thickness of 20 in. In addition to the 3 cu.yd. of concrete per linear foot in the arch forms, which comprise about three-fourths of the circle, an average of one cubic yard per foot was required in the fourth or lower quadrant. The lining is heavily reinforced throughout, except for two 150-ft. lengths where solid rock was traversed. In these rock sections grout was forced between the rock and the concrete lining.

When the tunnel was driven, work was divided into three sections and advanced from six headings (*Engineering News-Record*, July 31, 1924, p. 168) but due to inequality of length of the three sections a somewhat different arrangement was followed in distributing the concrete guns, three guns being concentrated on the long section as the work drew to a close. Air compressors, materials storage and concrete mixing plants were located at the two portals and at one intermediate point. This made it necessary to line a 12,300-ft. length of tunnel working from the two ends.

As a first step in the lining operations the backfill shoulders were placed on either side of the invert, line and grade was established and forms were placed for the curb-like pour marked 1 in the sectional drawing, Fig. 3. This first pour served to hold the lower edge of the first steel forms and constituted a starting point for the arch-footing pour, marked 2.

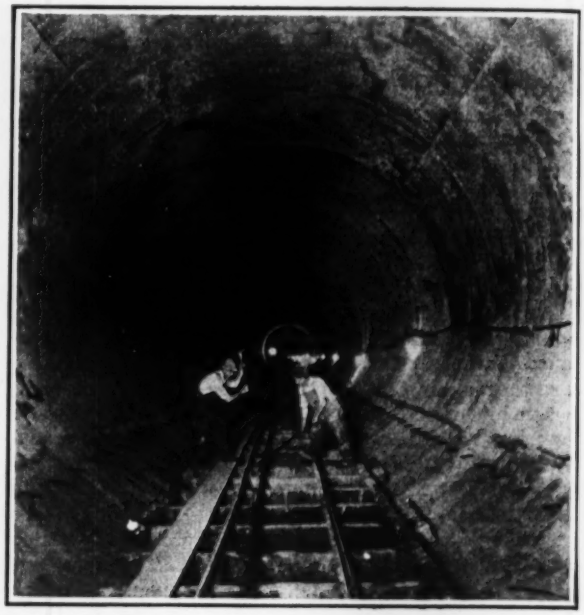


FIG. 1—SECTION OF COMPLETED TUNNEL

Pour 1, in addition to having wood forms of a shape that would leave a longitudinal groove to effect bond with the invert, was formed so as to leave transverse recesses in its upper surface of size and spacing to suit the reinforcing specified for each section. These grooves provided a support in the bottom of the tunnel for the reinforcing steel and at the same time assured the proper spacing. Iron pins 1 in. in diameter were

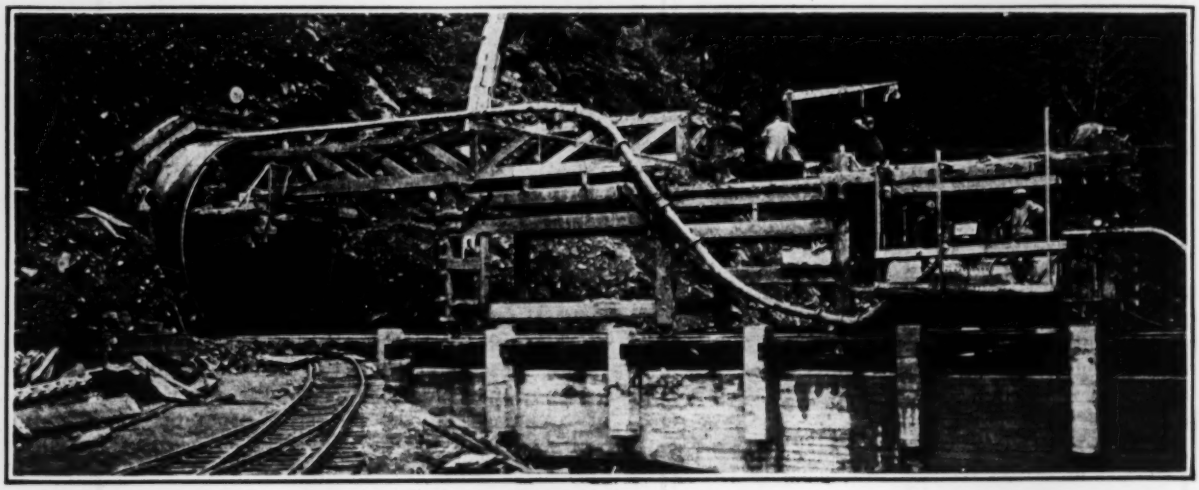


FIG. 2—GENERAL VIEW OF GUN JUMBO OUTSIDE TUNNEL

Cantilever truss which is used to support delivery pipe when the pipe end is not resting on forms is seen projecting over wedge jumbo in tunnel. Note winch on gun jumbo. Operator's station is at right of gun. First 3-ft. section of delivery pipe is made of rubber. The gun jumbo operated as a gantry traveler with opening permitting passage of concrete cars.

also placed with the forms in the face of this concrete curbing and were turned after the concrete had partially set, thus preventing bond so that when the forms were removed there would be left a hole convenient as an anchorage for the next section of forms.

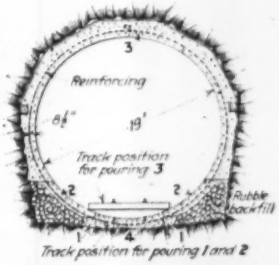


FIG. 3—SEQUENCE IN PLACING CONCRETE LINING

After the first pour had been made on both sides of the invert, 6x8-in. concrete crossties were cast in the invert at 8-ft. intervals. These ties, poured in forms placed between the wooden ties of the first track, were to prevent any danger of the curbs being shoved out of line by thrust. A notch in the upper face of these ties served as support for the wooden struts placed to prevent any slipping of steel forms for pour 2.

The concrete marked 2 was poured against forms fastened in place as shown in Fig. 5, held by U-bolts at the bottom and at the top by steel rods driven into the tunnel timbers and wedged against the angle iron on the upper edge of the forms. Two horizontal rows of ¾-in. bolts were placed in these forms, with the upper ends projecting, before the concrete was poured; the lower row for use in supporting jumbo tracks of 10-ft. gage and the upper as an anchorage for the arch forms. After the forms of pour 2 had been removed, the track was taken up and the rails replaced on standard railroad ties, spanning from concrete to concrete.

The first jumbo over the track in the elevated position was the hewing or templet jumbo carrying a templet to determine the amount of adzing necessary to give the required clearance in front of tunnel timbers. Its upper surface was stepped off in three levels to provide convenient working platforms for men using broadaxes or adzes in cutting away timbers that projected beyond the specified clearance. This hewing of timbers was made necessary by the fact that the ground continued to move more or less after the tunnel was timbered. The movement was enough in some sections to require complete resetting of posts or arch segments. The rule was not to hew timbers to a thickness less than 5 in.—where a cut to that thickness would not give the necessary clearance the timber was reset.

Reinforcing steel of a length to extend halfway around the circumference (plus a lap of 40 diameters) was bent outside the tunnel to the proper curve and was delivered along the tunnel track. In the lower half of the tunnel this steel was placed with the aid of a longitudinal cableway, 200 to 250 ft. long, slung from chain-hooks in the arch timbers. At one end this cable passed over a sheave and came down to block and tackle at floor level for convenience in taking up slack. With the aid of a carrier traveling on this cable each piece of steel was picked up near one end in such a way that the other end could be inserted beneath the rails of the track and threaded into place in the notches of the first pour.

In the upper half of the tunnel steel was placed with the aid of a jumbo onto which the rods in semicircular shape were slid over 4x4-in. skids extending up to the jumbo platform. A block and tackle slung from chain-hooks in the arch timbers was used to haul the bars up. On top of the jumbo three rollers, Fig. 7, helped to get the rods into place and also supported them until tie-wires could be fastened. The rollers were only ½ in. below the curve of clearance for reinforcing and hence wedges of this thickness were used to raise steel into place before the tie-wires were fastened.

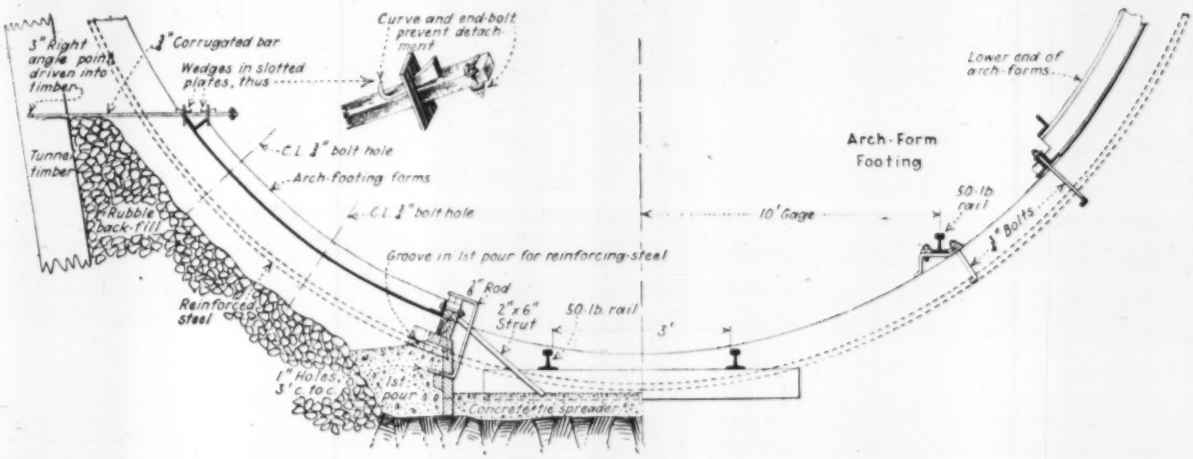


FIG. 4—DETAILS OF ARCH FORM FOOTINGS AND INVERT

The upper and lower rods were overlapped 40 diameters, the joints being staggered by shifting alternate rods five feet circumferentially. Overlaps were firmly fastened by tie-wires. In the arch the longitudinal rods were held in place by wires from the timbers and lagging overhead. The circumferential bars were in turn wired to the longitudinal reinforcing.

To insure a separation of 1½ in. between steel and tunnel timbers concrete blocks of this thickness were wedged in between the bars and the timbers, Fig. 5, wherever the spring in the steel tended to hold the bars in contact with the wood.

With the reinforcing all in place, the arch forms were set in position by a form jumbo, Figs. 5 and 6, 14 ft. long carrying four jacks placed at the proper points for lifting against steel shoulders set in the I-beams of the steel forms. The form jumbo picked up 10-ft. sections of the forms successively and set them in place, supporting the weight on the jacks until the lower parts of the forms were secured by clamps to bolts left projecting from concrete of pour 2 for that purpose.

The 10-ft.-gage track used for placing the forms was so accurately aligned, due to the accurate setting of the bolts in the concrete on which it was supported, that templet and form jumbos used it without any further checking of line or grade.

With a 70-ft. length of forms in place, constituting a setup for one shift's work, the wedge jumbo, 75 ft. long, moved up under the forms and prepared to remain there until the concrete hardened sufficiently to stand of its own strength. The wedge jumbo was really a working platform or staging for final bolting up of the forms and placing the 6x6-in. horizontal timbers, spaced 5 ft. apart, to strengthen the forms against the pressure of green concrete.

The arch forms, spanning the upper three-quarters of the tunnel section, were divided by two hinges into three parts, of approximately equal lengths measured along the arc of the circle. The plates of these forms were $\frac{5}{16}$ in. thick, riveted to circumferential I-beams which in turn were tied together by two longitudinal runs of angles in each of the three sections. The edges of the $\frac{5}{16}$-in. plates along the hinged joints were machined to insure a tight fit. Each 10-ft. section of these forms had an inspection window on either side and one in the center of the arch. The side openings were 2 ft. square in the form of hinged doors held shut by wedging a 2x4-in. timber against the door and beneath the inner flange of the I-beams. The openings in the top were 36x30 in. in size so that the plate to close the opening could be thrust through and then clamped down by wedging in a manner similar to that used on the side.

Using these forms as described in the foregoing moved them from one setup directly to another without subjecting them to rough handling or damage. In order to secure the smooth interior finish desired the forms were cleaned after every pour, using scrapers and brushes where necessary, and given a good coating of oil.

The type of concrete gun used was the same as that developed by R. C. Hackley for lining the Skagit tunnel (*Engineering News-Record*, Oct. 30, 1924, p. 700). As built for the Pit tunnel job these guns had a horizontal length of 10 ft. with a height of 4 ft. The ends were flat and the shell, made of $\frac{3}{4}$-in. steel, was reinforced by four $1\frac{1}{4}$-in. longitudinal rods extending horizontally through the gun and passing through angle irons riveted to the ends. Concrete was admitted through a 2-ft. circular opening in the top, covered, before applying air pressure, by a hinged lid with a rubber gasket, firmly clamped down with a heavy lever and held in place by a steel link.

Each gun was supported on four $1\frac{1}{4}$-in. rods slung from overhead timbers on the concreting jumbo which moved bodily along the track as the work progressed. To prevent vibration the gun was also braced against the jumbo frame with timber struts. Air was admitted by four $1\frac{1}{4}$-in. pipes lying in the bottom of the gun and pointing in the direction of the tapered outlet at the delivery end. The longest pipe or lead pipe terminated just back of the end of the 7-in. delivery pipe and the ends of the other air lines terminated at intervals between this point and the rear end of the gun. The location of the lead pipe end was found to be important, a slightly greater length failing to give satisfactory results.

As concrete was being dumped into the gun, the valves in all four air lines were "cracked" open so that the air admitted at several points along the bottom of the gun would prevent a solid compacting of the material before the charge was ready for delivery. From time to time during charging the operator would also occasionally open up one or more valves somewhat to distribute the concrete in the gun and prevent piling up in the center where it would choke the opening.

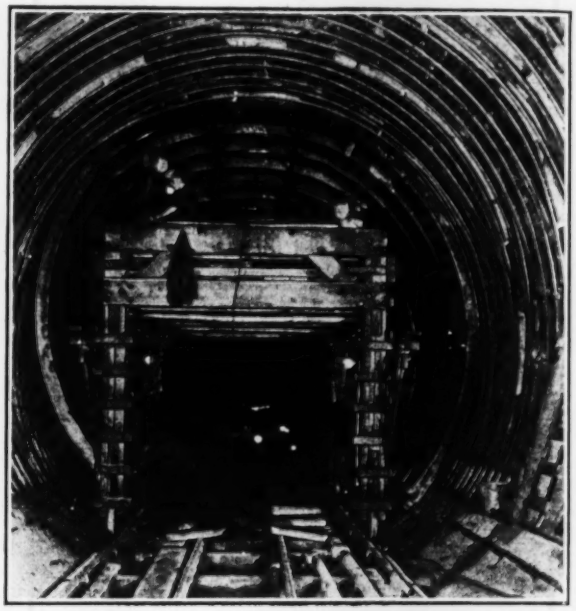


FIG. 5—PLACING STEEL FORMS FROM FORM JUMBO
The arch forms are located and held in place at the bottom by bolts projecting from the concrete. Note concrete blocks used to keep reinforcing away from tunnel timbers.

A $2\frac{1}{2}$-cu.yd. charge was found to be about right for these guns which had a water capacity of 3 cu.yd. With the charge in the gun, the lid and its seat were first hosed off to remove any spillage and then clamped down. By opening the valve admitting air to the lead pipe the operator started the forward end of the charge into the delivery pipe and after this was in motion gradual opening of pipe 2 and then pipes 3 and 4 forced the entire batch into the delivery line. Experience was found to be the only guide as to just how and when these valves should be operated. Normally about two minutes were required from the time the first valve was opened until the last concrete of the charge had left the pipe.

The gun crew consisted of 4 men; the operator, an assistant, a winchman and a man to handle the 100-ft. length of 3-in. rubber air hose which supplied the concrete gun from the 4-in. air line running through the tunnel. This flexible hose was made necessary by the frequent forward and backward moves of the gun gumbo as concrete was being placed.

Air pressures used toward the end of the job were 100 lb. per sq.in. at the gun. Using a long 4-in. delivery line this was the pressure found best after experimenting with 110 and 90 lb. per sq.in., respectively. If a larger supply line had been used this pressure could have been considerably reduced, it is believed. The four air lines into the gun were served by a 3-in. manifold, on which an air gage was mounted at the operator's station for his convenience in observing the action of the gun. The 4-in. compressed air line laid in the tunnel when driving operations were under way

was connected up as a through line for the use of the concreting crews and was served by four compressor installations. Three of these had capacities of 3,000 cu.ft. per min. and the fourth 2,100 cu.ft. per min., this last being used as a reserve. With these sources of supply and with a maximum of 4 guns working on the same shift, pressures during the discharging of concrete did not drop below 70 lb. per sq.in. in the gun. This favorable operating condition was secured by placing a 17-ft. by 30-in. air receiver on each gun jumbo.

The gun jumbo, Fig. 3, was 47 ft. long in the main section and operated as a gantry traveler with the central opening large enough to permit the passage of 2½ cu.yd. concrete cars built high enough to deliver to the gun by gravity. On a platform above the clearance required by concrete trains, this jumbo carried a winch to move the outfit along the tunnel as the forms were filled. This was accomplished by the use of cables extending in both directions from the winch to the chain-hooks in the arch timbers or to the steel forms where these had been bolted to concrete lining.

In addition to this main portion of the jumbo there was a pipe support in the form of a cantilever section which overhung 32 ft. and beyond the end of this cantilever the pipe extended 34 ft. more, supporting its own weight for this distance except when discharging concrete, at which time the end of the pipe rested on the steel forms. The delivery pipe did not actually rest on the cantilever section except when blocks and wedges were inserted to carry the pipe weight in this

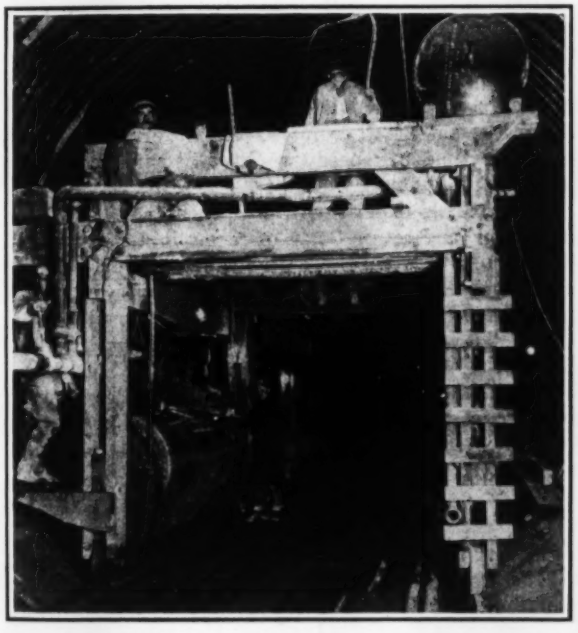


FIG. 6—CLOSE VIEW OF GUN JUMBO IN TUNNEL
Concrete cars pass under the jumbo and discharge by gravity into gun. Note air receiver on jumbo. Rubber air hose at left enables jumbo to move without interrupting air service.

way. The advantage of this separation was that the pipe could be thrust into the steel forms as much as 66 ft.

On leaving the gun, the delivery line which was a standard 7-in. steel pipe, rose to the center of the arch by the use of four curves on 15-ft. radius, each curved section having flanged ends to give a smooth path for the concrete. The straight section of the pipe, 68 ft. long, had welded joints, thus making it possible for it to slide along the forms in advancing or withdrawing. The life of the pipe in the bends varied from 3 to 10 days, that is, 600 to 2,000 cu.yd. of concrete. On one gun a 3-ft. section of rubber hose, 1½ in. thick,

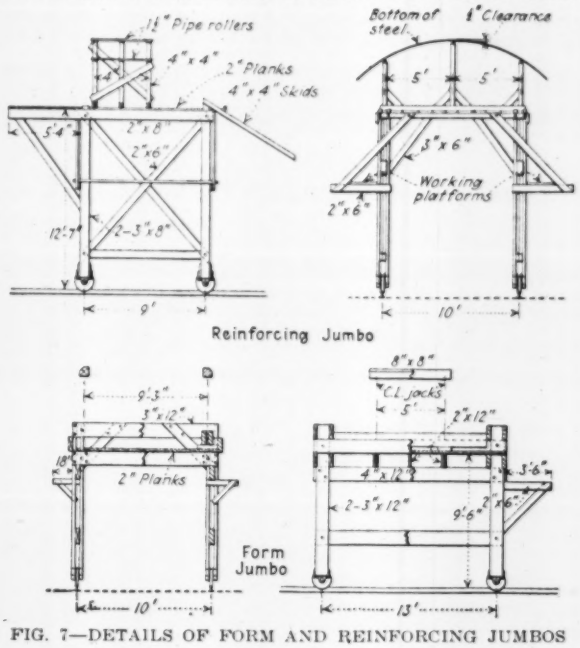


FIG. 7—DETAILS OF FORM AND REINFORCING JUMBOS

was tried out to determine the comparative life of this material. About 6,000 cu.yd. were placed without destruction of the hose. The shortest life on the pipe line occurred in the top bend which was curved in two directions. When a leak occurred, a steel patch faced with rubber was clamped on. This was later replaced by a steel patch welded in place provided other portions of the section gave promise of further life.

At the delivery end the pipe was flattened to an ellipse about 5 in. high so as to permit sufficient clearance for sliding along on the steel forms without striking the reinforcing. To the end of the pipe was attached a baffle box, 5 in. high, 14 in. wide and 3 ft. long. The concrete made a right-angle turn in this box and came out both open ends. Runners made of 2x¼-in. strap iron were welded to the bottom of this box and their ends turned up so as to facilitate sliding on the forms. From this baffle box two bolts passed through ears on the end of the pipe and when clogging occurred these bolts were taken off, the pipe was backed away from the form and lowered onto chains slung from the roof while the obstruction was removed.

This flattening of the opening at the end of the pipe caused a few cases of trouble with choking at this point. There was practically no trouble with blocking at other points in the delivery pipe. In lining 2¾ miles of arch there was only one case of choking, back of the flattened end, which required cutting into the welded section of the delivery pipe. The mix used in the gun was 1:2½:3½, the rock in the aggregate being limited to a maximum diameter of 2 in. So long as the rock was kept down strictly to this size no difficulty with choking occurred, all obstructions, on being cleared out, were found to result from larger pieces of rock which had inadvertently gotten into the mix.

The first day's pour was started with the outlet end of the pipe having the full 7-in. diameter. The flat-

tening was at once decided upon after the first few moves with a full-size baffle box showed that without more clearance it was practically impossible to prevent forward and backward movements of the line from catching in the reinforcing which occasioned as much as four or five hours' delay at a time in releasing the box and restoring the steel to position. The conclusion from this experience was that at least a 2-in. clearance is necessary between baffle box and reinforcing steel.

All concrete in the arch forms was discharged from the pipe at the crown of the arch and allowed to flow down the forms into place. The inspection windows in the sides and top were used to determine whether the flow was satisfactory. Satisfactory placement and a very smooth finish on the interior was secured by the use of a small calking air hammer with a cut-down feed which was used to vibrate the forms as the concrete went into place. Backward and forward movements of the gun jumbo, and hence of the delivery line, were frequently made, by the use of the winch, during placing to secure the desired equal distribution. An average of 8 trips of the delivery pipe over the full length of each form set up was ordinarily made, thus depositing the concrete in layers each about 2 ft. deep.

The delivery of concrete from the cars to the gun was facilitated by three men with shovels who were particularly useful in giving it the equivalent of a "re-mix," that is, turning it over as they spaded it down

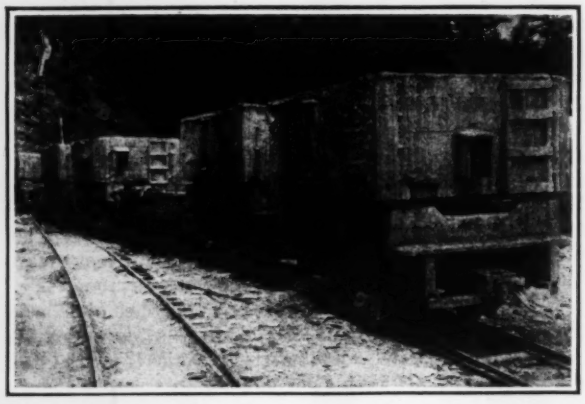


FIG. 8—HIGH CARS USED FOR DELIVERING CONCRETE
These cars do not tilt, the bottom being made to slope toward the outlet in the center of one side, closed by a gate. From this level a chute conveys concrete into the gun.

into the spout from the corners and sides of the car, Fig. 9. In fact, on the longest hauls which ranged up to 8,600 ft. and on which the concrete did not get into the gun until about half an hour after leaving the mixer, two ¾-in. air jets were also used to agitate the concrete in the car before it was discharged into the gun. This was accomplished by thrusting the air pipes into the concrete around the sides of the car, thus separating it from the walls, aerating it somewhat and giving opportunity for water which had risen to the top in transit to get down into the more compacted mass below.

In the long section of the tunnel where three guns were used toward the end of the work, two were supplied from the same portal on alternate shifts. Each gun was operated for only eight hours per day, thus allowing time for making a new form set-up each day without necessitating the operating of four crews in the tunnel in a way that would interfere with the use of the tracks for concrete delivery. With an 8,600-ft. haul three concrete trains each handling two batches for the gun were necessary to keep each gun crew supplied and this operation precluded the use of this

FIG. 9—AGITATING CONCRETE WITH COMPRESSED AIR
Workman in right foreground is using shovel and two others are thrusting down ¾-in. pipes through which air jets loosen up concrete compacted by 8,600-ft. delivery. Spading and air jets constitute a "re-mix."

portion of the tunnel tracks for any other purpose during that time.

After the kinks were eliminated and things were brought to a smooth working basis, rapid progress was made. It was quite common for a crew to finish a complete pour of 70 ft. (about 210 cu.yd. of 85 batches) in 6 hours. The schedule called for filling the forms set up for the shift but no more. Thus delay in placing meant overtime and speedy work meant getting through early with pay for a full shift.

After a little experience the form crew was able to clean, move and set up 70 ft. of forms in approximately seven hours, leaving the entire equipment in position to place the concrete. The concrete crew would then ride into the tunnel on the first concrete train.

The Pit River No. 3 tunnel is being lined by the Pacific Gas & Electric Co.'s department of electrical construction and operation, with O. W. Peterson as engineer of general construction under the vice-president, P. M. Downing. G. M. Wehrle is general superintendent on the job.

Water Main Breaks in Creek

Floating débris caused the breakage of a water main laid across the bed of Raccoon Creek, with serious interruption to the water supply of the Indiana State Sanatorium at Rockville, Ind., in December, 1924. A similar break occurred in May, 1923. In the original plans it was intended that the main should be buried in a trench, but it is stated that during construction, about 1910, permission was given to lay it on the bed of the creek. This crossing is about 500 ft. from the wells on one side of the creek and 1,200 ft. from a pressure tank on the other side. After repairs had been made under the direction of Dr. Amos Carter, superintendent of the sanitarium, it was first proposed to relay the main in a trench and case it with concrete, but a test well developed a sufficient supply of water for the sanitarium and the crossing has been abandoned.

Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

Aurora, Ill.

AURORA, ILL., AND STOLPS ISLAND

ON THE FOX RIVER, in Kane County, 38 miles west of Chicago. Headquarters for Chicago division of Chicago, Burlington & Quincy R.R. Terminal of suburban service for this railroad and the Chicago, Aurora & Elgin high-speed interurban line from Chicago. A large manufacturing center, producing machine tools, road and earth handling machinery, water-works pumps, stoves, conveying machinery, pressed steel machinery of all kinds, including lockers and bins, and having cotton, woolen and paper mills and a wood-working machinery establishment. Finished products in 1921 amounted to more than forty million dollars. Stabilization is effected by the diversity of the manufacturing establishments and also the intense farming area as a background. Founded in 1842. Population (est. 1925), 45,000.

THE engineering problems of Aurora are all affected by the peculiar topography, that is a steeply sloping valley running down both sides to a river with an island therein forming a large section of the city. A strip of fairly level land along the east bank is occupied by the business section. This means that caring for runoff is an easy problem and naturally that all sewers drain directly into the river. Formerly the railroad was much more of an impediment than it is today. It paralleled the river and further divided the town. Three years ago it completed a grade separation which initially was to be a concrete retaining wall to hold an earth fill. This mode of construction was abandoned after a short stretch was built and three lines of columns used. The viaduct with its open effect has unified the town and the growth has been greatly promoted by the improvement.

The water supply of the city is not affected by surface drainage but as in many other northern Illinois cities it is obtained from wells to the Potsdam sandstone about 2,200 ft. below the surface. Although a hard water it is cool, free from contamination and considered an excellent supply. As northern Illinois is in the terminal moraine of glacial action about half and half clay and gravel form the surface materials. Foundations, if at all demanding it, can easily reach the limestone which varies in depth from near the surface at the east side of the river to perhaps 60 or 80 ft. on the west side. With a few exceptions trenching and excavating are not a serious proposition. These exceptions are when backfill is of clay which arches over the trench when not thoroughly tamped and may not be broken down until long after the original work is completed. Recently a 10-ton roller broke through into a trench over a sewer laid 30 years ago. Usually, however, there is no difficulty of this kind and excavation is done by trench machines through the gravel and clay. Occasionally, the latter contains large boulders which make machine work somewhat difficult.

City Government—Aurora has a commission form of government with a mayor and four commissioners. The mayor handles public affairs, is superintendent of police, fire and legal division. The four commissioners split up the other departments according to their previous training and ability. The mayor is Col. Charles H. Greene, commander during the World War of the Bassens district at Bordeaux, France, which command contained 10,000 engineering troops engaged in army construction work, building docks, cantonments, roads, sewers, warehouses, bridges and miscellaneous structures. He is considered a high-class executive. The city engineer, Walter E. Deuchler, reports to the commissioner of streets, public improvements and superintendent of streets. However, all engineering work gravitates to his office and he has charge of water, sewers, paving and construction of all kinds, including bridges, sidewalks, curbs and any incidental engineering that may come from the other commissioners. He does not, however, have charge of the operation of the garbage plant or collection. The garbage is collected twice weekly in the summer and once in the winter. It is burned in incinerators. Since the haul is short, only a few motor-driven vehicles are used; the steel tank 2-ton wagons are drawn by two horses.

Mr. Deuchler was formerly a consulting engineer and when he came into the office there were comparatively few matters under his charge. He has now gathered in practically all engineering work of the city. He handles it by divisions, which are established according to the kinds of work. One division handles all paving, another handles all the work for water supply extensions and water service. A third division is that of special assessments which is handled by one man. The main office keeps track of all the inspections, checks and notes on official drawings, and of changes that are made in the construction.

The City Plan—Recently one of the draftsmen of the engineering department has been employed in making a detailed city map, which Aurora needed and which will be used in connection with the work of the city plan commission that has been authorized recently. Mr. Deuchler anticipates good results from the proposed city plan, because the commission is organized on a permanent basis and its sole duty is to carry out the work of city planning and development during the years to come. He is of opinion that in the past most city-plan projects have been filed away and all too soon forgotten because no official body has been in authority to enforce the provisions of such plans.

Outside men are brought into the office in the winter to design structures they are to build during the coming season. One engineer handles the bridge engineering and inspection work. Designing of bridges has been done mostly by the city engineer, although the bridge engineer handles most of the details. Mr. Deuchler, four years ago, designed a complete sewage disposal plant for 8,000 people, consisting of a two-story Dortmund tank and necessary appurtenances, which has worked very successfully, serving about 4,000 people.

Financing for most of the public improvements is by special assessment with general bond issues for certain things, such as the major portion of bridges. Bridges being a special feature of Aurora, a method of special assessment for benefits derived by property near approaches has been worked out.

Authority for a sanitary district was recently carried by a 12 to 1 vote. Sewage disposal plants for the city and for perhaps ½ mile beyond the city limits will be built ultimately downstream, intercepters skirting the river. This district operates under the same law as several other districts in Illinois. The board is permitted to levy taxes and has bonding power.

Pavements—Paving in Aurora is largely asphalt, on a concrete base; 46 miles are in service, 6 miles being laid this year. There are 14 miles of brick, 3.4 miles of concrete, the latter laid four years ago. During the last three years Warrenite bitulithic has been used extensively. No new work is done by force account although maintenance is cared for by city forces. The oldest asphalt pavements, about 25 years old, are in the business district and are getting rough. They are repaired by filling the holes with asphalt and broken stone. Pavement patching has been developed to a fine art by the street maintenance department. The old pavement is cut back square, the sides painted with asphalt and then the opening filled two-thirds full with tamped broken stone of large size, over which is spread hot asphalt. A finer size is placed on top of this lower layer and more hot asphalt applied. The top is dressed off with torpedo gravel. Another maintenance feature which has been developed is to fill cracks in asphalt paving every year, just as cracks in concrete pavements are filled. Sheet asphalt pavements which are 25 years old are estimated to have had not less than ten years' life added to them by this means. One crew of four men with an asphalt kettle and truck has been able to cover the whole city.

In Aurora, asphalt paving has been studied scientifically. The conditions to be met are temperatures from 25 deg. below zero to 98 deg. above. The amount of asphalt used varies from 9 to 13 per cent, depending upon the grading of the sand. The idea is to have a slight excess of asphalt. To obtain the right kind of work complete laboratory control is maintained. On one sheet asphalt job in 1916, as much as 12½ per cent of bitumen was used in the top mixture but the sand was so perfectly graded that no trouble from shoving or excessive marking has been experienced in hot weather, even though this street has carried most of the Lincoln Highway traffic.

Handling patented pavements and other patented articles by city engineers in Illinois has recently been made somewhat simpler than heretofore. In 1917 a law was passed whereby a patented pavement may be asked for if bids on somewhat similar non-patented pavement are requested at the same time, thereby obtaining competitive bids on two or more types. Aurora usually calls for bids for sheet asphalt, Warrenite bitulithic and asphaltic concrete at the same time, the competition thus created between the different types resulting in close figures on the work and a considerable saving in cost to the city. Concrete pavement bases over new trenches excavated and filled prior to paving are reinforced with ½-in. round bars set 12 in. c. to c., as a precaution against the settlement of the paving over such trenches. The bars extend 1 ft. beyond the sides of the trench. To relieve the roadways of as many conduits as possible, gas pipes and telephone conduits are now being placed in the parkway.

Engineering Work

With reference to pavement crossings of sidewalks, an intentional stepdown of not more than 6 in. into the gutter is now required of pedestrians. The former practice of bringing the pavement up to a level with the top of the curb at the crossing has been abandoned on all new work, as that plan required a plate forming a covered water passage which is likely to become clogged and to freeze in winter, while the resulting raising of the pavement surface impairs the service of the mechanical street sweepers. Formerly the radius at corners was 8 ft. Now it is not less than 15 ft. and may be 20 ft., varying with the width of the paved roadway. On acute angles of street intersections as high as a 40-ft. radius is used.

Material from excavations finds a ready demand for filling abandoned and worked-out gravel pits and low-lying lands. Snow removal is practiced only in the business districts, the snow being hauled away and dumped over the river bank into the river. Snow removal machines used all over the world are made in Aurora.

The question of sidewalk grades needs far more attention than it is ordinarily given, in Mr. Deuchler's opinion. In Aurora, grades are planned by districts in new subdivisions and all other structures are built to the sidewalk grade. For instance, water mains are usually laid 5 ft. deep in Aurora to prevent freezing. If laid 5 ft. from the surface and subsequently the street grade is set for a 2-ft. cut, the water line must be lowered before paving. In too many cases present grades which were established over twenty years ago indicate that the city engineer was over-ruled and the property owner had sufficient influence to make the grades to suit his own convenience rather than that of the street as a whole. These old irregular grades cause a great deal of friction and difficulty when improvements are made. Gradually Aurora is eliminating them.

Mr. Deuchler has devised a new inlet for use between street-car tracks. It extends from rail to rail and in addition to a top grating permits water to obtain entrance into an inlet alongside each rail below the top of the inlet, thereby utilizing the flangeway as a gutter. This inlet has been used extensively in neighboring cities. A new street railway franchise calls for the construction of all tracks, track foundations and pavement foundations by the railway company, with all plans therefor subject to the approval of the city. The pavement wearing surface throughout the track area is then constructed by the city. By this provision it is hoped to get uniform pavement surfaces and to eliminate damage to pavements from poor tracks.

Bridges—The Fox River is the essential feature of Aurora. Stolps Island is the essential feature of the river, with bridges from one side to the other, since the population is divided about 65 per cent on the east side and 35 on the west side. It is rapidly filling up with business buildings and is also something of a civic center, as it is the site of the city hall, one well of the water-works system, public library, lodge and

Of the Small City

club buildings, and public utility offices. Three new bridges are now under way, two connecting Benton and Holbrook Sts., on either side of the island, and the other spanning the west branch of the river at Main St. About twenty years ago the public library was intentionally so located as to prevent a bridge connecting these two streets by means of a roadway across the island, so the street must be swung to the north, in front of the library.

Miscellany—A tourist camp has been laid out in the city park with a shelter house, fireplace, well and toilet with dry closets. There are no sewers, as this is outside the town, on the Lincoln Highway to Joliet.

Another miscellaneous activity or duty of the city engineer's office was the survey of an 18-hole municipal golf course for which a water system of galvanized-iron pipe was laid out. A centrifugal pump taking water from a lagoon about 125x75 ft. and 3 ft. deep brings the water supply. A deep-well pump furnishes water to the lagoon where the water is allowed to warm up before it is pumped to the greens.

A certain amount of street traffic work is done by the city engineer. He drew up a plan for an ordinance to indicate available and desirable parking space, also the location of parking on the streets whether at an angle or parallel. The proper parking angle for the majority of Aurora streets he found was 30 deg. Wider streets might permit greater angles. Some street widening for the sake of traffic has been recommended but nothing done. Although no success as yet has been obtained, condemnation has been suggested of property for future widening in the residence district where the values are now low as compared with what they will be when the areas become business property.

Aurora is the first Illinois city with a comprehensive zoning ordinance which carried its zoning ordinance to the Supreme Court of the state. The Supreme Court held the ordinance unconstitutional but recently gave the city a chance for a rehearing, because the finding was based upon a decision in California, that has recently been reversed.

Mr. Deuchler has his staff so organized that he can spend practically all his time on special investigations or in checking up his various departments one after the other during the day. Like so many other Middle West cities, Aurora has only recently grown up and put its entire engineering problems in technical hands; a day with the city engineer indicated capable technical hands.

Yellow Paint for Fire Hydrants

IN THE salty and frequently foggy air of New London, Conn., George D. Watters, the city engineer, found that red paint used on fire hydrants deteriorated rapidly, losing its life or turning an ineffective pink. He tried a yellow metallic paint and as a result of observations covering a number of months, ordered all of the fire hydrants, and then traffic signs, painted with that color. To try the effectiveness of the yellow paint he chose a hydrant by the railroad track, where it would be subjected to the dirtiest conditions, and another on the beach, where it would get the maximum effect of salt air. After several months the hydrants showed about as brightly as when first painted, so he began the use of yellow paint on all of them, until now every hydrant in the city has been repainted.

So effective has the yellow paint been that he has extended its use to all traffic signs he can possibly change and on the frames of all lanterns hung as warning signs on construction jobs. He also has found that fewer lanterns have been stolen since the frames were thus painted. No special brand of yellow paint is needed, in Mr. Watters' opinion, so long as it is a good grade of metallic paint.

Pumping Station Improvements at York, Pennsylvania

By F. G. Cunningham
Of Fuller & McClintock, Engineers, New York and Philadelphia

THE York Water Co., which supplies water to the city of York, Pa., has recently contracted for a new boiler and additional pumps and filter plant units; these represent the immediate part of a comprehensive long-term construction program which was developed in a report made by the writer's firm. The report confirms, as most suitable for future needs, the present source of supply and general scheme and location of works. The improvements recommended are of the nature of modernizing and enlarging present facilities. The water is taken from Cadorous Creek, pumped against a static lift of 290 ft. to large reservoirs on a hill, filtered, and distributed by gravity.

Practically all the pumping station load is now carried by a single 320-hp. boiler and one 8-m.g.d. pumping engine, both installed some ten years ago. Furnishing reserve service for these units are two wornout boilers, and two 5-m.g.d. steam pumps. The boilers are being replaced by a 280-hp. water-tube boiler equipped with a hand stoker. In the space occupied by the direct-acting pumps will be installed an 8-m.g.d. steam-turbine-centrifugal unit to furnish reserve service and a 5-m.g.d. pumping engine to meet anticipated growth in demand. The new equipment is designed to operate with 170 lb. steam pressure, 125 deg. superheat and a total head of 350 ft.

The present coal consumption of 6 tons daily is deemed too small to justify the use of automatic stokers, but the new boiler is so set that an automatic underfeed stoker may be readily added when desired.

The turbine unit consists of two close-coupled, 12-in. pumps in series, 5-stage geared turbine, a condenser and auxiliaries. The hot-well pump is of the water-driven centrifugal type and the air pump is of the hydraulic type. Water to drive the auxiliaries will be bled from the discharge main and passed through the auxiliaries in series. The guaranteed over-all duty of the unit is 129 m.ft.-lb. per 1,000 lb. of steam.

Comparisons worked out beforehand justified the selection of the turbine type of unit for reserve service and of the more expensive pumping engine type for regular service. The pumping engine chosen is of the horizontal cross-compound type, with attached auxiliaries, suction condenser and primary heater. The guaranteed duty is 163 m.ft.-lb. per 1,000 lb. of steam.

The steam piping system is being rebuilt with steel valves, fittings and flanges and joints. The floor of the engine room is being raised to provide headroom in the basement. Light, ventilation and accessibility in the basement will be improved by hatchways in the floor and by piping revisions.

One of a Series of Articles on the Details of Design and Layout of Different Types of Industrial Buildings

Chicago's New Produce Market: Buildings—Equipment

New Site Has Six Three-Story Concrete Structures Giving 1,500,000 Square Feet of Floor—Complete Sanitary and Business Facilities for Each Occupant

A WHOLESALE produce market established by private capital and an organization of dealers, providing modern accommodations and facilities for about 300 commission firms and dealers in a group of six large reinforced-concrete buildings, is an important enterprise now being carried into effect at Chicago in order to meet changing conditions due to city development.

For many years the produce and poultry business, which is estimated to amount to more than $100,000,000 annually, has been concentrated on South Water St., adjacent to the congested loop district and occupying groups of old and more or less dilapidated buildings. As a result, the sidewalks have been almost impassable and the wagons of the dealers and retailers, backed up in solid phalanx along the curb lines, have practically blockaded this street and seriously hampered traffic on the main streets which intersect it. In addition, the whole neighborhood has been littered with dirt and vegetable refuse. Since there are few suitable railroad yards in the vicinity there has been a long haul to the market district, while a large proportion of this haul and of the subsequent haul by retailers has been through the congested business section of the city.

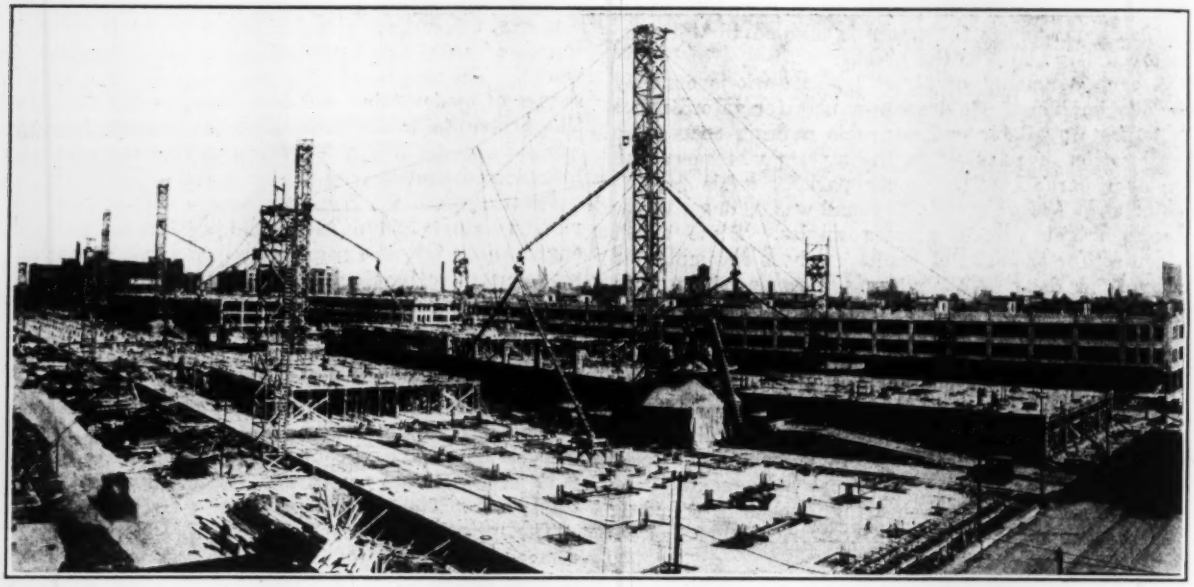


FIG. 1—BUILDING THE CHICAGO PRODUCE MARKET
Three buildings partly completed, and three being concreted. Four concreting plants, each elevator tower spouting to four hoppers for charging buggies which deliver concrete to the forms

New Market Site—During the past ten years several attempts have been made to eliminate this obstructive condition by the removal of the produce market business to another site, out of the congested district and with more modern and more sanitary facilities, but these failed owing to the difficulty of uniting the numerous commission firms and dealers for concerted action or the acceptance of any definite project. Without such action, any firms removing to a new location would necessarily lose a good part of their business to those remaining at the old established location. Action became necessary, however, with the decision of the city to begin work on its river-front improvement in rebuilding South Water St. as a double-deck thoroughfare. This will wipe out the old rookery section, and after unsuccessful litigation to postpone the city's work, the produce dealers realized that they had to get out and had better co-operate in establishing their business at some new center.

After much effort and negotiation a group of the larger firms formed the South Water Street Removal Co. to determine ways and means of securing a new location. As a result, the South Water Market Trust was organized, which, after considering various sites, acquired a 15-acre plot for a large market at 15th St. and South Racine Ave., within a short distance of the loop district and convenient to a number of railway freight yards.

For the construction of the new market, the Chicago Produce District Trust was organized. On the site selected a group of buildings is being erected which will provide 166 three-story and basement units 24x80 ft., one or more of which may be purchased by a firm, according to the size of its business. Fig. 1 shows the several buildings in different stages of prog-

ress, and Fig. 3 is a view of the first building when nearly completed.

While the site is adjacent to several main line railroads there are no tracks into the market, as it was considered that the movement of cars would cause confusion and that it would be preferable to haul goods from the team yards by wagons and motor trucks. The several railroad yards within easy reach of the market have a capacity of about 3,500 cars, while projected improvements will increase this to about 6,000 cars. It is estimated that the reduced cost of trucking, reduced delays and consequent reduction in spoiling or waste of perishable goods will effect a material financial saving.

Layout of Market—From the general plan, Fig. 2, it will be seen that there are six buildings or blocks uniformly 81 ft. 8 in. wide, with lengths of 576 to 816 ft. These front on 90-ft. streets with a 48-ft. alley in the rear, except that a 35-ft. alley on the south side is between the last row of buildings and the retaining wall of the railroads, which are elevated above the street grade. A 74-ft. transverse street separates the two groups of buildings. Reinforced-concrete paving in the streets or driveways and in the alleys will be 10 in. thick, with crushed granite aggregate in the top 3 in. to give a hard wearing surface.

Each building has three stories and basement, with the first floor 30 in. above the street paving in order to facilitate handling goods to and from trucks and wagons. Goods will be received at the rear and delivered to purchasers at the front, where a 15-ft. concrete platform or sidewalk extends along the building. Iron trap doors in this platform open into the basement beneath it. To provide for carrying electric conduits, brine pipes and telegraph and telephone lines under

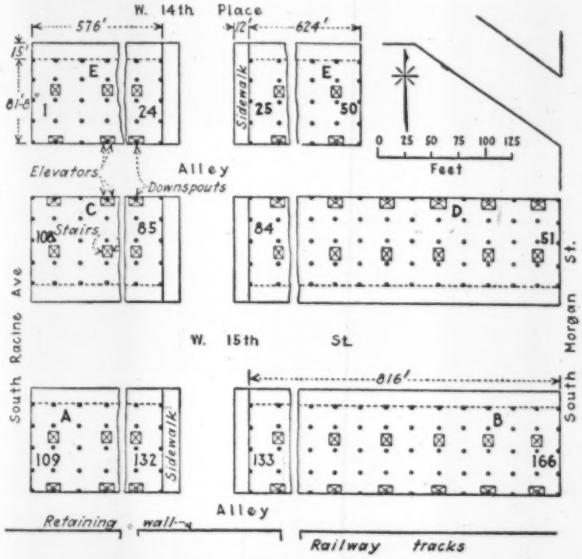


FIG. 2—GENERAL PLAN OF MARKET

the sidewalk, an easement for a tunnel is provided for in each purchase contract, so that these facilities can pass through all of the individual units, as indicated in Fig. 4. A 15-ft. canopy extends over the front platform and there is an 11-ft. canopy along the rear. The total floor area will be about 1,500,000 sq.ft. A typical cross-section is given in Fig. 5.

***Service Facilities*—A special feature of the design is** that the merchant whose business requires only one unit will have facilities equal to those of his neighbor who takes four or five units. This will be seen from the part floor plan in Fig. 4. Thus each unit 24x80 ft., with three stories and basement, has an electric elevator, 8½ ft. square, of 4,000 lb. capacity, an iron stairway, electric light, telephone and telegraph con-

FIG. 3—TYPICAL DESIGN OF MARKET BUILDINGS
End view of the first of six buildings. Alley and railroad tracks at rear.

nections, water, gas, washing sink, toilet rooms for men and women, a 12x12-in. flue for ventilating the basement and a 12x12-in. tile-lined smoke flue or chimney, the four flues for each pair of units being formed in a brick stack. At the front of the first floor is a doorway 20 ft. 5 in. wide, with two sets of steel "accordion" folding doors, and at the rear an 11½-ft. doorway with a single set of similar doors. In each unit the floor is sloped to drain to a catch basin with sewer connection, so that the floors can be thoroughly flushed and washed. All scale pits, elevator pits and other depressions are also provided with drains.

Market Buildings—Reinforced-concrete construction of the flat slab type was adopted for the buildings, after careful consideration of a fireproof steel-frame type of building. The reasons given for this selection were that it was felt the concrete would provide better-ventilated and better lighted structures at less cost, while it would also permit changes to be made more quickly and cheaply to meet the desires of individual occupants in regard to various details, such as stairways and ceiling inserts. Since most of the units had been sold in advance of construction, it was practicable to introduce such changes in or additions to the general plans while the work was in progress.

In each building the framing plan forms two rows of side panels 20 ft. 10 in. x 24 ft. and two rows of interior panels 20x24 ft., with slight variations at the end units to fit the length of the building. Story heights, from floor to floor, are 10 ft. 2½ in. for the basement, 12 ft. 2½ in. for the first story and 11 ft. for the two upper stories. The typical construction consists of circular columns with flaring caps, supporting an 8½-in. floor slab with rectangular drop heads 4¾ in. deep over the column caps. Wall columns are rectangular, with bracket heads. Spread footings on the stiff blue clay are sufficient for the foundations in view of the light load to be carried, these footings being figured for a bearing pressure of 4,500 lb. per sq.ft. on the clay.

Four-way reinforcement is used for the 8½-in. floor

slabs, the bent bars being carried on supporting rods which rest on small concrete blocks, as shown in the typical design of floor, Fig. 6. In the rectangular belts every third bar is straight. Deformed round bars are used for the slab reinforcement, but stirrups, ties and spirals are of plain round bars. All main bars are of rerolled T-rail steel, complying with the requirements of the Chicago Code and the American Society for Testing Materials. A gravel concrete with mix of 1:2:4 is used for the slabs and 1:1:2 for the columns.

Floors, Roofs and Walls—The floors are designed for a live load of 175 lb. per sq.ft. For the cement floors no special finish is provided in construction, beyond good floating and proper troweling of the ½-in. top course, which is applied monolithically. It is expected, however, that individual occupants later will apply liquid hardeners and pore-sealing finish, while others will lay maple plank or wood block or 1½-in. asphalt flooring. In offices, linoleum will be used extensively. The roof has an 8½-in. concrete slab insulated with cork board and covered with built-up composition roofing. It is sloped to drain toward downspouts placed in chases in the rear wall.

Gray terra-cotta glazed tile facing is used on the front and end walls of the buildings, with gray slag brick on the rear or alley side (Fig. 2). This brick is used also in the elevator pent-houses on the roof. Each building is divided at mid-length by a transverse 12-in. brick fire wall, without doorways. In the rear bay, a 2-ft. beam extends from every other wall column to the first interior column, passing between the elevator hatches, in order to support the floor slab. Under the fire wall these beams extend across the full width of the building. Transverse partitions of 6-in. tile are built between the columns to divide the blocks into 24-ft. units or as required by the occupants. Hard, smooth glazed tile is used for the partitions in order to provide a sanitary and durable wall surface, without additional finish.

Windows, Doors and Canopies—On the concrete lintels are brick curtain walls, with large window openings fitted with hollow steel sash on the front and rolled steel sash with ventilator sections in the rear wall.

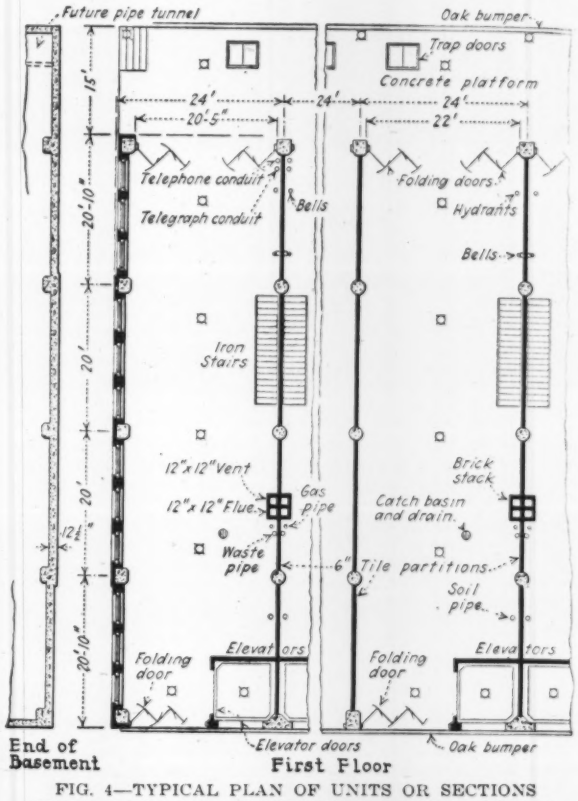


FIG. 4—TYPICAL PLAN OF UNITS OR SECTIONS
The six buildings comprise 166 units, 24 x 80 ft., each with three floors and basement.

Obscure wire-glass is used for all rear sash and also for the upper panels of the folding doors. These doors are of steel, with special track, bolting and hinges to permit the middle sections to be operated as an ordinary pair of hinged doors in inclement weather. The bottom panels are insulated with asbestos board between the steel plates. All interior stairs are of iron, with scored steel or cement filled treads. Malleable cast-iron in-

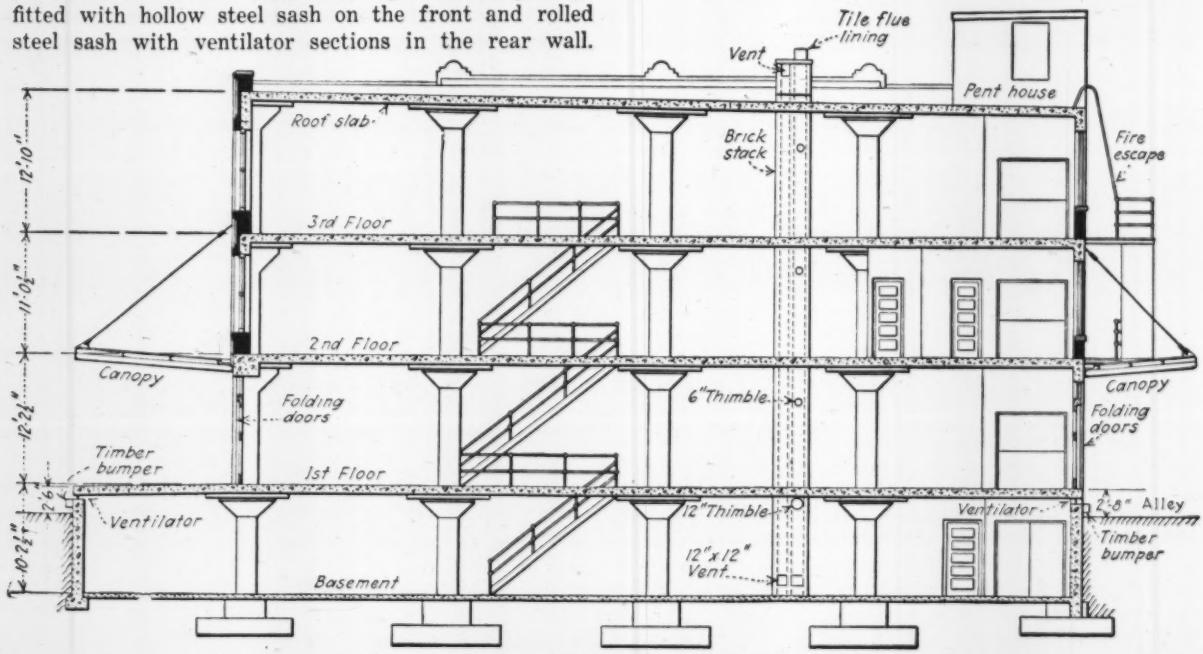


FIG. 5—CROSS-SECTION OF MARKET BUILDING

serts of the threaded socket type are concreted in place in the ceilings where desired by occupants, for hanging bananas and other produce, as well as for the attachment of pipe coils in refrigerating rooms. These inserts may also support small motors or other apparatus for special equipment.

Steel frame canopies 15 and 11 ft. wide extend along the front and rear of each building. This framing is anchored to the lintels and supported by 1¼-in. tierods with turnbuckle connections to anchor rods in the walls, as shown in Fig. 6. Where these anchorages in the rear wall come at the chases occupied by down-spouts, two short angles are attached to the wall, extending across the chase and having a pin and clevis attachment for the anchor end of the tierod. The front canopies are of the puttyless skylight type, with obscure wire-glass, while the rear canopies are covered with precast cement tile. In the fascia beam of each canopy ½-in. holes are formed at 12-in. intervals for the attachment of canvas curtains to protect goods piled on the front

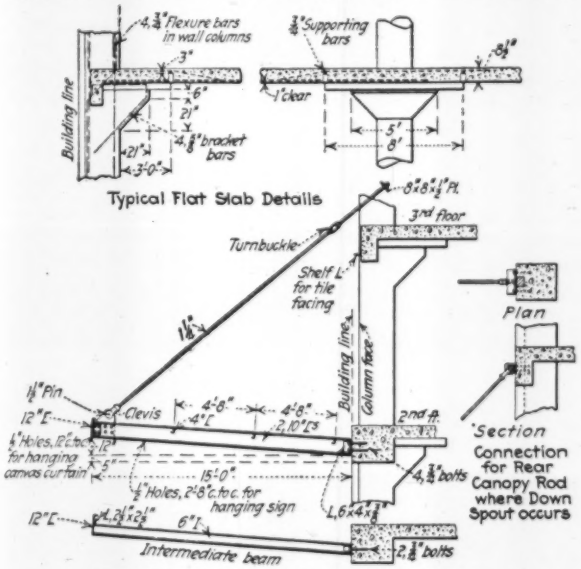


FIG. 6—FLOOR AND CANOPY DETAILS

platforms or at the rear doorways. Still another detail is the punching of holes in the flanges of the transverse beams for the attachment of the dealers' signboards.

Heating and Other Services—In view of the great variation in kind and amount of heat required or desired by different purchasers or occupants, each will provide his own heating system, accommodated by the flues already mentioned. Some will use stoves, "gas-steam" radiators or electric heaters, while others will install complete steam or hot-water plants. Furthermore, some desire heat only for offices and toilet rooms, while others desire heat for other portions of their premises. In general, heating is required for only about four months of the year. A central heating plant was considered, but was abandoned as not being practicable. All electric service for heat, lighting and power will be furnished from the underground distributing mains of the Commonwealth-Edison Co., and adequate street lighting will be provided. No sprinklers or other general fire protection apparatus is installed, being considered unnecessary; but there will be the usual street hydrants, while occupants may provide extinguishers.

Cold Storage—Cold storage rooms for produce which is sold quickly will be provided by such purchasers as desire them in their own units and at their own expense. Brine service pipe lines are run in the tunnel space under the sidewalk, with connections provided for each unit; this service gives temperature both below and above 32 deg. F., as may be required. For prolonged cold storage, facilities will be provided by the Central Cold Storage Co., which is closely allied with the South Water Market Trust and is now erecting east of the market site a cold-storage plant of ample capacity; from this plant the brine pipes of the market buildings will be served. As adjuncts to the market, in addition to the cold-storage building noted above, negotiations are under way for the construction of an office building, a garage and an incinerator plant in the immediate vicinity.

Construction Work—Rapid construction of these buildings was essential on account of the near approach of the time limit for vacating the old quarters on South Water St., so that when the contract was let in January, 1925, it provided that the first building must be completed and ready for occupancy by July 1, and all the six buildings similarly completed within nine months. Clearing the site was an easy matter as it was occupied mainly by old residences and small industrial buildings. Work was started first on the southwest building, and as each stage was completed here it was resumed for another building. Numerous steam shovels excavated the ground to the basement level and the holes for footings were dug by hand. Concrete for the footings was made by several small portable mixers and either spouted or wheeled into place. Large mixer plants with elevator towers and chutes were then erected for building the superstructure, together with a number of platform and skid hoists for handling material.

This market was designed for the Chicago Produce District Trust by Fugard & Knapp, architects, with Lieberman & Hein as structural engineers. A. G. Schutt, consulting engineer for the South Water Market Trust, is in general charge of all design and construction work for the owners. H. H. Frenzel is his assistant engineer in the field. The general contract was let to the McLennan Construction Co., and the construction is in charge of Otto Kretzger, superintendent for the company. The estimated cost of the buildings is $4,500,000, with $2,500,000 additional for real estate, paving, lighting and other facilities.

Crushed Limestone and Tile Waste in Concrete

Good concrete can be made from crushed limestone or hollow tile waste, the U. S. Bureau of Standards finds. The only drawback to the use of such material is the angularity of the pieces, which makes the concrete flow less readily and makes it harder to handle by the methods used in large construction enterprises. This drawback can be remedied by oversanding, the Bureau believes. Large quantities of waste material accumulate around quarries producing dressed limestone, and the same is true of plants manufacturing hollow tile. An investigation was undertaken by the Bureau of Standards to see if this material could not be used for concrete. Test cylinders were made up, using several standard proportions, and using as the coarse aggregate limestone in some of the cylinders, crushed tile in others, and Potomac river gravel in others. The other conditions were made as nearly alike as possible. In the tests the limestone concrete proved slightly weaker than the gravel, and the tile concrete about one-fourth stronger.

Repair Cost of Asphalt Pavements at Columbus, Ohio

Costs Kept Since 1888—Figures for 37 Years Averaged and Analyzed—Charted Results Indicate a Critical Age Period

By R. H. Simpson
Chief Engineer, Division of Engineering and Construction, Department of Public Service, Columbus, Ohio

THE improved roadways of the city of Columbus, Ohio, total about 6,500,000 sq.yd., consisting of 3,900,000 sq.yd. of brick; 1,800,000 sq.yd. of asphalt; 300,000 sq.yd. of macadam; 240,000 sq.yd. of concrete; 185,000 sq.yd. of granite and a small yardage of wood block, asphalt block, cobblestone, etc. A record of the cost of maintaining most of these pavements has been kept by the engineering department of the city for many years past, and in the case of asphalt pavements the record is complete for all construction since 1888. During the past few years a classification and tabulation of these data have been undertaken by the writer, for the purpose of securing definite information about the service record of each particular improvement as shown by the repair cost. These figures have been completed for all asphalt pavements, about 300 separate improvements, and it is thought that the results will be of general interest to engineers especially those engaged in the construction or maintenance of pavements.

Prior to 1900, these asphalt pavements were laid on a natural cement concrete base, 6 in. thick, except in a few cases, where the asphalt was used for resurfacing over old boulder or cobblestone pavements. Subsequent to 1900, portland cement has been used in the construction of the base. During the earlier years, this concrete mixture consisted of 1 part portland cement, 4 parts sand and 8 parts stone. Later this mixture has been strengthened, and at the present time and for 12 years past the proportions have been 1 part cement, 2½ parts sand and 5 parts broken stone. The thickness of foundation has remained at 6 in. During the past 12 years about 175,000 cu.yd. of asphalt have been laid over old brick pavements. The asphalt mixture has averaged about 10½ or 11 per cent of bitumen with sand grading closely following standard practice.

Practically all of the repair work has been done by the "cut out" method. Surface heaters have rarely been used. Prior to 1907, the repair work was done by contract, the area of the repair surfaces being measured and payments made on a unit price basis in accordance therewith. Since 1907, all repair work has been done by city forces, a plant and organization being maintained for that purpose. To ascertain the cost of repair of any pavement, the area repaired is measured and recorded at the time the repair is made, but the unit cost to be applied to this area is determined at the end of the season's work, by dividing the total expense for the year including labor, material, supplies, repairs to equipment and plant, a charge for use of plant, superintendence, etc., by the total yardage of repairs made. This gives a unit to apply to each pavement and a total that is not influenced by the location of the pavement or its distance from the plant. A more rational comparison between pavements is thus obtained than if the actual cost of each particular improvement was used.

The repair costs are recorded on cards prepared for the purpose, one side showing the construction data and the reverse side the maintenance. Fig. 1 shows the card used. It will be noted that there is shown for each improvement the area repaired each year; repair cost each year; unit cost in terms of total area and the cost per yard per year. This last figure is really the service test of a pavement and gives a more rational comparison between two or more pavements than if the actual cost at each age period is used, as the latter is somewhat erratic, being influenced by inadequate budgets in some years. The cost per yard per year of a pavement is the average yearly cost of repairs for the period under consideration. It is obtained by dividing the total cost of repair for the number of years under consideration by the area of the improvement and this quotient by the number of years. For example, the total yardage of all pavements in Columbus that are

STREET Dryden Road, from Parsons Ave. to 22nd St.

MAINTENANCE COST

YEAR	AGE	SQ. YDS REPAIRED	COST	COST PER YD.	SQ. YD. COST PER YEAR	TOTAL COST TO DATE
1897	9	43	64.64	.0051	.0006	64.64
1898	10					
1899	11					
1900	12	833	1249.71	.0994	.0087	1314.35
1901	13	681	1000.56	.0795	.0142	2314.91
1902	14					
1903	15	14	20.43	.0016	.0124	2336.34
1904	16					
1905	17	103	127.40	.0101	.0115	2462.74
1906	18	5	6.89	.0005	.0109	2469.63
1907	19	329	494.15	.0392	.0124	2963.78
1908	20	248	190.14	.0151	.0125	3153.92
1909	21	147	116.82	.0093	.0124	3270.74
1910	22	232	219.08	.0174	.0126	3489.82
1911	23	266	185.80	.0148	.0127	3675.62
1912	24	834	827.56	.0658	.0149	4503.18
1913	25	1178	1075.32	.0855	.0177	5578.50
1914	26	113	110.94	.0087	.0174	5689.44
1915	27	626	628.21	.0499	.0185	6317.65
1916	28	832	914.31	.0727	.0205	7231.96
1917	29	645	623.86	.0495	.0215	7855.82
1918	30	150	308.77	.0246	.0216	8164.59
1919	31	611	1254.40	.0998	.0241	9418.99
1920	32	455	923.28	.0726	.0256	10342.27
1921	33	739	928.32	.0718	.0271	11270.59
1922	34	1674	2159.59	.1718	.0312	13430.18
1923	35	447	759.43	.0604	.0321	14189.61
1924	36	384	521.56	.0415	.0330	14711.17

FIG. 1—SAMPLE RECORD CARD OF PAVEMENT REPAIRS

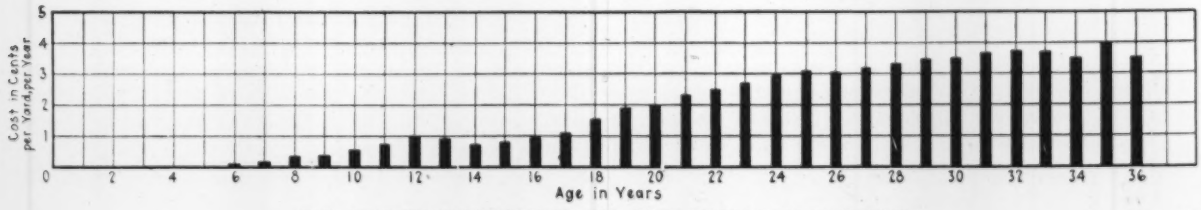


FIG. 2—REPAIR COSTS FOR ALL AGES FROM 1 TO 35 YEARS

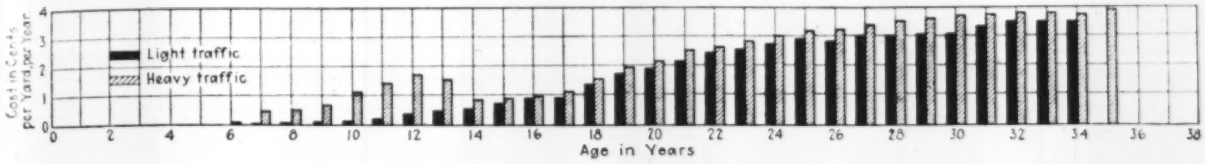


FIG. 3—COSTS COMPARED FOR LIGHT AND HEAVY TRAFFIC

at least ten years of age is 660,027 and the total expenditures on these pavements for repairs during this ten-year period has been $33,044. By dividing this cost by the yardage and then by 10 we get $0.005 which is the cost per yard for pavements ten years of age. In this manner the repair cost for each improvement of a total of about 300 has been ascertained.

Fig. 2 shows graphically the repair costs of all asphalt pavements in the city for all ages from one to thirty-five years. The figures from which the diagram was constructed were obtained by adding together the costs for each improvement at a certain age-period regardless of course as to when the pavements were laid. This diagram indicates that, except for an increase in cost from the tenth to the thirteenth year, the repair costs increase somewhat uniformly with the age. These results are of course for the average of all pavements and do not consider any variation in volume or weight of traffic.

Fig. 3 shows a comparison of the cost of repairs of light traffic and heavy traffic pavements. The difficulty of any accurate division of pavements into these arbitrary classes is recognized and in explanation it may be said that in the discussion all pavements in business sections, in railway terminal districts and all thoroughfares have been considered as heavy traffic pavements, and all others as light traffic. It will be noted that the repair costs for the light traffic pavements increase

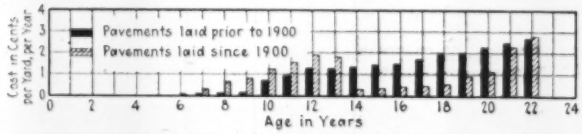


FIG. 4—COSTS PRIOR AND SUBSEQUENT TO 1900 COMPARED FOR HEAVY TRAFFIC

gradually up to the seventeenth year, after which the increase is more rapid. The heavy traffic pavements show a rather marked increase in cost up to the twelfth year. From the fourteenth to the seventeenth year the cost is less than at the twelfth year period but increases again rather uniformly up to the thirtieth year. It is interesting to note that there is very little difference in repair cost of light and heavy traffic pavements after the fifteenth year; as would naturally be expected, the cost of the latter is in excess of the former at all ages.

In the preparation of the data from which these diagrams were constructed it was noted that there was, at certain age periods, considerable difference in repair costs of pavements laid prior to 1900 as compared with the more modern pavements. Fig. 4 shows a comparison of repair costs of heavy traffic pavements laid prior to 1900 with those laid subsequent thereto. It will be observed that on the former the cost increases with the age at a fairly uniform rate except for an abrupt rise from the ninth to the twelfth year. On the other hand the latter shows a marked increase in cost during the early years, a lower cost after the thirteenth year, with another sharp increase at the twentieth year, indicating a period of heavy maintenance at approximately 10-year cycles. This diagram shows clearly the effect of traffic on repair costs. The traffic on the earlier constructed pavements was relatively light during the early ages, and repairs correspondingly low in cost during this period. The more modern pavements have been subjected to excessive traffic during the earlier age periods, a traffic for which they were not designed. This has resulted in distortion to the asphalt surface of some pavements which had excessive bitumen content and has required heavier repair during this period.

Fig. 5 shows a comparison of repair costs of light traffic pavements laid prior to 1900 with those laid subsequent thereto. It is interesting to note that the latter show a lower cost than the former at all ages, the difference being marked after the tenth year. This diagram would indicate that the older pavements had disintegrated or deteriorated not from traffic but from

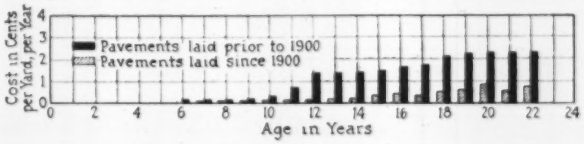


FIG. 5—COSTS PRIOR AND SUBSEQUENT TO 1900 COMPARED FOR LIGHT TRAFFIC

lack of traffic and that the more modern pavements subjected to moderate traffic are being maintained at a much lower cost than the former at all ages. It seems clear therefore that a moderate amount of traffic is beneficial to asphalt pavements.

A study of the repair costs has indicated that the pavements on streets which contain railway tracks have required heavier maintenance than pavements on thoroughfares without tracks, the volume of traffic being somewhat comparable. Fig. 6 shows a comparison of repair costs of pavements on thoroughfares with street railway tracks with pavements on other thoroughfares. It should be understood that these costs include only that portion of the pavements beyond the limits of the railway tracks, the railway company being obligated to pave between rails and one foot outside thereof. While the record shown is for a comparatively short period, the comparison is marked and shows clearly the effect on repair costs where heavy traffic is confined to a narrow path and in that path in one direction only. It will be

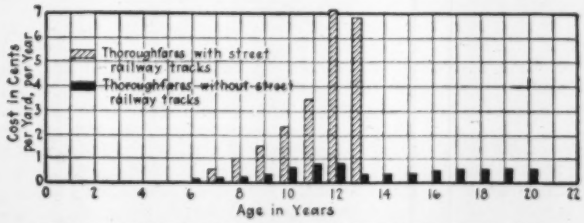

Cost in Cents per Yard, per Year
Thoroughfares with street railway tracks
Thoroughfares without street railway tracks
Age in Years

FIG. 6—COSTS COMPARED ON STREETS WITH AND WITHOUT RAILWAY TRACKS

noted that on thoroughfares without car tracks, he cost increases with the age of the pavement and that although there is a decided rise in costs from the tenth to the twelfth year, the increase is fairly uniform. It is also interesting to note that after the fourteenth year the repair costs on these thoroughfares is no greater than for the light traffic pavements, indicating that even where traffic is large in volume the maintenance is moderate where conditions are such that traffic can spread out over the entire surface of a pavement and not be confined to one path.

It will be noted that in all of the diagrams the repair costs for heavy traffic pavements show an abnormal rise from the ninth to the thirteenth year and in most of them the cost is less after this period for a few succeeding years. These facts seem to be evidence that there is a critical period in the life of all heavy traffic pavements and that this period is from the ninth to the thirteenth year after construction. We should not then form any definite conclusion as to the merits of a pavement until such pavement, after about twelve years' service, with moderate maintenance, is found to be in a satisfactory condition.

Rules of Ethical Practice for Contractors

Issued by the Associated General Contractors.

THE working principles by which members of the Associated General Contractors are to be governed in their relations with client owners and the public, with other agencies of construction, and with members of their own profession, are as follows:

Owners and the Public—Fair and bona fide competition is a fundamental service of our industry to which clients and owners are entitled. Any act or method in restriction thereof is a breach of faith toward this Association and a betrayal of its principles.

But the competition cannot serve its legitimate purpose unless it operates under conditions alike fair to owner and to contractor.

Observance of ethical conduct toward the contractor by those who utilize his competitive bidding will be encouraged in proportion as he himself abides by the ethics of fair competition. Only when he respects the code of this Association can he reasonably ask others to respect it.

Ethical conduct with respect to competitive bidding is defined in the following paragraphs:

1. Competitive bids preferably should be submitted only when a definite time and place for the opening of all proposals have been fixed, at which all bidders or their representatives are permitted to be present.

2. The contractor's professional knowledge is the result of his training and experience and if he is called upon for preliminary estimates or appraisals it is proper that he should be paid in the same manner that engineers and architects are paid for similar service.

3. Bidders should neither seek nor accept information concerning a competitor's bid prior to the opening, nor by any method suppress free competition. It is equally improper for the owners to use bids in an effort to induce any contractor to lower his figures.

4. On private work, if all competitive bids are rejected, new bids should not be submitted within 60 days unless warranted by a substantial change either in the work to be performed, or the market, or other basic conditions affecting cost.

5. The amount of a bid should not be altered after the opening except when substantial change is made in the work, or when further bidding on alternate items is requested. In event of such change or further bidding, the contractor should bid only on the items specified and should increase or decrease the amount of his bid only in proportion to the change or alternate involved. Any reduction of a bid disproportionate to such change or the submission of any alternate which in effect produces such a disproportionate reduction, constitutes unfair competition. This shall not be construed as prohibiting the low bidder from decreasing his bid.

6. Contractors should co-operate in advising architects, engineers and owners with respect to the relative costs of various alternates while plans are being prepared and thus seek to reduce the number of alternates to a nominal maximum.

7. When bids are solicited and received by an owner on a lump sum basis, no competitor other than the low bidder should solicit the work on a percentage basis, or any other form of cost-plus contract, provided however, that any competitor shall have the right to accept the work on a percentage basis if tendered him without guaranteed maximum cost or at a guaranteed maximum cost not less than his original bid.

Engineering and Architectural Professions—Local and national co-operation in matters of mutual concern should be the basic policy of members of this Association in their relations with the engineering and architectural professions; the purpose of this co-operation being to establish a clear conception of respective functions and responsibilities, to guard against uneconomical or improper practices, and to carry out constructive measures within the industry.

Ethical conduct toward architects and engineers demands:

1. Support should be given to all efforts of these professions to maintain and extend high standards of conduct.

2. Contractors should give full credit to the value of the services rendered by the architect and engineer and neither undermine or disparage their functions or usefulness.

Sub-Contractors and Those Who Supply Materials—The operations of the contractor are made possible through the functioning of those agencies which furnish him with service or products, and in contracting with them the contractor is rightfully obligated by the same principles of honor and fair dealing that he desires should govern the actions toward himself of architects, engineers and client owners.

Ethical conduct with respect to sub-contractor and those who supply materials requires that:

1. Proposals should not be invited from any one who is unqualified to perform the proposed work or to render the proper service, or to whom, in event that his proposal should be the lowest received, the contractor would be unwilling to award the contract.

2. The figures of one competitor shall not be made known to another before the award of the sub-contract, nor should they be used by the contractor to secure a lower proposal from another bidder.

3. The contract should preferably be awarded to the lowest bidder if he is qualified to perform the contract, but if the award is made to another bidder, it should be at the amount of the latter's bid.

4. In no case should the low bidder be led to believe that a lower bid than his has been received.

5. When the contractor has been paid by a client owner for work or material, he should make payment promptly, and in just proportion, to sub-contractors and others.

Operating in Foreign Territory—The conduct of any member operating within the jurisdiction of a local chapter of which he is not a member and the conduct of the members of that chapter should comply with the following:

1. The non-chapter member should ascertain from the local chapter the prevailing scale of wages for the various crafts and should not offer employment at rates in excess of those established.

2. Should a non-chapter member have difficulty in securing a sufficient number of workmen, he should so notify the local secretary, who will take immediate steps to assist him.

3. It is the duty of the local chapter to investigate immediately the difficulties cited and to provide in good faith every assistance that it renders to its own members under similar circumstances.

4. It is the duty of the non-chapter member to abide by the suggestions of the local chapter and co-operate with it without disrupting the prevailing scale of wages.

5. Should the measures undertaken by the local chapter fail to relieve the situation, the entire matter may be placed before the Executive Board of the National Association for its ruling, and such ruling shall be final.

Discipline—Any member who refuses to abide by this Code of Ethical Practice shall be subject to discipline as provided by Article II, Section 7 of the Rules of Procedure of the Association.

California's Land Settlement at Delhi

Its Difficulties and Recent Measures for Rehabilitation—Some Conclusions From Delhi Experiences

By Nathan A. Bowers
Pacific Coast Editor, *Engineering News-Record*, San Francisco

CALIFORNIA'S second colonization venture, located at Delhi in the San Joaquin Valley and opened to settlers some 3½ years ago, has just been given a fresh start by legislative enactment of four measures designed to improve the prospects of settlers now on the land. When these laws were passed Delhi was facing a crisis. The financial and economic situations had become very unsatisfactory to all concerned and with poor credit and lowered morale, extensive abandonment of allotments was expected unless some new plan of operation was put into effect.

FIG. 1—TYPICAL FARM HOMESTEAD AT DELHI
In foreground, finely pulverized sand, typical of the soil on the settlement. Windbreaks alongside house and at extreme right are intended to check sand drifting.

This is in sharp contrast to the history of the Durham colony (*Engineering News-Record*, Dec. 5, 1918, p. 1014) the state's first land-settlement venture, established in the Sacramento Valley in 1917 and a marked success from the start. Delhi was planned according to the same general program as Durham but was begun under wholly different conditions; also management and policy have changed hands. Delhi has turned out to be even more of an experiment than Durham because of the unexpected difficulties encountered. In fact, these handicaps were so great that a legislative committee investigating the Delhi project early this year reported it to be "a financial failure" and recommended that "the state of California should never again enter into a land settlement scheme." Other men familiar with the facts and of good judgment state the case rather differently. They hold that in view of the changes in administration and the variety of unexpected difficulties under which Delhi has labored, this particular venture has produced no clear-cut proof as to the success or failure of the policy originally laid down in California's land settlement act. To pronounce that policy a failure on the strength of the Delhi showing is merely to declare opposition to it, because even if Delhi were a 100-per cent failure there would still be the successful showing at Durham to bring up the average.

Development History—In 1919 the Land Settlement Board bought, at an average of $95 per acre, 8,400 acres adjoining the south boundary of the Turlock Irrigation District, and arranged with that district for a water supply, thus laying the foundation for the Delhi project. The board then installed a concrete-pipe distribution system; this type though expensive, was considered necessary because the sandy nature of the soil would have caused high seepage losses and undue maintenance costs with open ditch distribution. A considerable part of the tract lies above the Turlock canals, and pumps were installed to raise water for these areas. Twelve wells were also sunk in certain low sections for drainage by pumps; this drainage water could be pumped into the supply lines to supplement the Turlock supply.

After adding the cost of pipe and other general improvements to the land purchase price, the state had to sell farms to settlers at an average of $230 per acre. On this a cash payment of 5 per cent was required and the balance was spread in semi-annual payments over 36½ years with interest at 5 per cent. These payments on the land plus taxes and water charges brought up the settler's yearly cash payments to $33.49 per acre. Water charges total $3.78 per acre per annum, made up of $1.98 paid to Turlock and $1.80 expended by the Delhi management for pumping, water tenders, etc.

These figures do not cover the charges for concrete pipes needed for distributing water on each farm (which cost an average of $56 per acre) nor the carrying charges on buildings and farm equipment such as fences, windbreaks, tools, stock, seed, etc.

Agricultural Conditions—The tract was opened to entry in several successive divisions, and to date 4,800 acres (57 per cent of the area purchased for the colony) have been colonized. The average period of residency to date is about 3½ years. Three classes of allotments have been offered, (1) for general farming, averaging 26 acres; (2) for poultry, averaging 7 acres; and (3) for laborers, averaging 2 acres. The land now under irrigation is in alfalfa, orchard and vineyard in the proportion of 4, 2 and 1, respectively. The total population of the colony is about 800, made up of about 220 families holding allotments and some 15 families renting farms.

The soil on the project is very light and sandy, and requires special care in upbuilding and maintenance in order to be productive to a satisfactory degree. It has a low water-holding capacity, requiring to be fertilized every year to yield good returns, and is subject to wind action to a high degree. In short, compared to farm land as a whole throughout California, the soil is poor—difficult to bring into and maintain in a condition of

productivity sufficiently intensive to justify the cost involved. It should be stated, however, that alfalfa can be made to produce heavily on certain parts of the tract.

The danger from blowing is greatest, of course, when the land is first being cultivated. Early in the history of the colony some $17,000 was lost by the blowing out of alfalfa, just planted. With knowledge gained from experience this danger is now being met by special protection against the wind, consisting of lightly disking in manure, straw or even weeds just after sowing. The cost of this protection ranges from $10 down to about $5 per acre according to materials and methods. To prevent foundations from blowing out from under buildings, bamboo windbreaks are used. These can be put up quickly at low cost and are used throughout the project for temporary protection while a more permanent windbreak, usually of poplars or alders, is getting started a little farther away from the buildings.

Early Outlook—When the Delhi project was opened for settlement, enthusiasm ran high and the belief of settlers and state officials alike was that the success of Durham would be repeated. Very little capital was required of settlers, loans could be obtained for all necessary improvements, there was a feeling that "the state will see us through" and many settlers with no considerable assets even planted orchard, which could not produce returns for several years at best. This was the heyday of hope and anticipation.

Disappointment and Complaint—As time went on the funds of the land settlement board were exhausted, and the expected additional appropriations did not materialize. Difficulties of subduing this light, sandy soil were becoming manifest. The state's administration changed from favorable to unfavorable. At the same time the bottom fell out of the market for farm products. The net result was that the credit of anything affecting Delhi went down almost to the vanishing point.

Then, following the example of farmers on federal irrigation projects, the settlers clamored for relief, and a radical element came to the fore and stirred up discontent among the settlers. Discussion of the impossibility of getting loans that had been promised or expected, threats of violence, and a general atmosphere of depression and hard times among the settlers and in the project headquarters, all contributed to the sum total of disadvantages under which the project labored. Settlers who sold out and left the colony all took away less than they had put into their holdings, the losses ranging from 25 to 75 per cent of the original investment. In some of these cases the state has taken a still further loss after the settler moved.

Debts Not Paid—State funds for promised loans to settlers were exhausted early in the history of this project and settlers used this as an excuse for deferring interest payments. About 95 per cent of the settlers became delinquent in payments to the state, confident that there would be no foreclosure. About 70 per cent were behind on obligations to the Federal Land Bank (contracted when state funds failed). But even when conditions were at their worst only about 10 per cent had not paid the Turlock water assessment; to sacrifice water service meant the loss of crops and was only one step removed from abandonment.

Unpaid debts to the state by no means indicate the actual status of individuals or the project as a whole. Included among the delinquents are settlers who came to the project with enough money to get a good start, who have done well and who could have made the state payments continuously had this been a necessity. No definite information is available as to the actual number of delinquents that were absolutely unable to make payments to the state. There is such a discrepancy however between the 95 per cent delinquent to the state and the 10 per cent delinquent to the Turlock irrigation district for water charges that it is certain that more would have paid had the state payments been a necessity. The delinquencies on the Turlock water charges, of course, include those who have failed because of inadaptability or family troubles, or who for other reasons were in the "misfit" class.

Unfortunately the Delhi venture became involved in politics when the present state administration disagreed with the policies under which California's state-aid projects had been launched. Since last year the Delhi colony has received considerable publicity in the daily press, much of it not at all helpful to colonization.

FIG. 2—HOUSE ON FARM LABORER'S ALLOTMENT AT DELHI

Bamboo fence at right is typical of windbreaks erected close to structures on the side from which the prevailing winds come, to prevent undermining of foundations.

New Aid from State—With affairs in this condition, about a year ago a new analysis of the situation was made, a settlers' executive committee was formed, and a movement was started to work out some feasible plan for re-establishing credit and giving the settlers new encouragement. The ultimate result of this endeavor, entered into jointly by the settlers and friends of the project, was the framing of four legislative measures. These bills, which have now become laws, have completely changed the prospects for ultimate success of the colony and have immeasurably improved the morale among the settlers.

The new legislation accomplishes four objectives as follows: (1) It cancels, in effect, the unpaid interest to date (amounting to $350,000) on three appropriations to the Land Settlement Board which aggregate $2,000,000 and represent the state's investment in Delhi. (2) It does away with interest on this same $2,000,000 investment for the next five years, which is, in effect, the sacrifice of about $400,000 more of expected returns. (3) It appropriates $250,000 to complete construction work on the project, to pay outstanding obligations and to meet definitely obligated loans to present settlers. (4) It amends the original land settlement act of 1917 to authorize revisions in contracts and to legalize the other three measures.

In other words the state acknowledges as loss and writes off an expected return of $750,000 from this venture, and also appropriates $250,000 for completing and carrying on the project. This last-named figure

was made $100,000 less than would otherwise be necessary, by the decision to sell off 700 acres of the less desirable undeveloped land instead of adding it to the area on which pipe is yet to be laid. The $250,000, of course, is an addition to capital investment which the settlers are expected to repay.

With the passage of these new laws credits are being re-established and there is renewed enthusiasm among the settlers, who believe that these changes will "make the project solvent and self-supporting without further appropriations and with sufficient margin to carry the overhead in the future."

According to another point of view this $750,000 loss corresponds to the loss that all private individuals who bought and developed farm land at 1919 prices have had to write off, one way or another. In the Delhi case until the state absorbed and wrote off a loss of about 30 per cent on its total cost the interest burden was greater than the settlers, taken as a whole, could bear. The consensus of opinion on the project, at least, is that if some such legislation had not been enacted at this time the losses to the state in disposing of abandoned lands would have greatly exceeded the write-off.

A Summary, and Some Conclusions

A summary of significant facts and conclusions that come to light in an analysis of the present Delhi situation is presented in the following:

(1) The soil is comparatively poor and hard to handle.

(2) The land was bought when prices were inflated, and this plus the expensive development work put heavy interest burdens on settlers and made it very difficult for them to meet payments. Nor could they sell out without a considerable loss.

(3) The requirement of a cash payment of only 5 per cent and the ready availability of loans put the bars down so low that settlers had but little equity in their allotments—perhaps not enough to bring out their best efforts.

(4) Experience at Delhi indicates that no loan should be made to a settler without a definite and satisfactory statement of just how he expects to repay it. Here comes in the fundamental question of whether the primary function of the state should be merely to aid the settler by easy terms and low interest on the purchase of land and the irrigation system alone or whether it should also help him finance his agricultural development. However, even if considerable help is given in financing farm operations, the Delhi experience suggests more rigid requirements on loans than were demanded there before the funds were exhausted. Where the state has so much investment at stake and where the failures of individuals react so unfavorably on that investment, it is obvious that there must be pretty close financial supervision over the settler and a certain amount of control over his development plans. Students of the California colonization schemes are frank to admit not only that this is desirable but that it must always be a feature of projects of this sort.

(5) The policy of making chattel mortgages has been most unsatisfactory. Two-year loans on baby chicks and five-year loans on farm implements, for example, are difficult to collect, unduly increase office overhead and encourage the settler to lean on the state.

(6) The two-acre allotments for farm laborers which were in great demand at first (while pipe making and other construction work was plentiful) have not worked out as satisfactorily as had been expected. This experience at Delhi is contrary to that at Durham, where the laborer farms have made the best showing of all allotments and have frequently been the stepping stones to larger holdings. One of the reasons for the less satisfactory situation at Delhi is that there these small holdings have become farms in the same sense as the larger tracts; the laborers have planted much the same crops as those on the larger farms, with the result that at the time when the larger farms need labor the men on the two-acre allotments are themselves busy.

(7) Finally the amount of ready capital brought in by settlers has been one of the most important factors in the Delhi venture. The cost of agricultural development (constituting an addition to the irrigation development cost and coming principally at the outset before the farm is producing) has been too much for the average settler to meet adequately; that is, he has had to substitute, compromise or postpone.

This is just the reverse of what the project requires, because the soil is hard to subdue and the investment needed for agricultural development is usually high.

The Question of Settler's Capital—It is significant that the most successful farms on the project are those on which enough capital has been invested to bring them up to a highly productive state, i.e., to permit an efficient productive program.

The problem of where to fix the minimum amount of capital with which settlers on a project will be accepted is affected, obviously, by general economic conditions as well as by conditions on the tract to be developed. At Delhi the cash requirements were very low, and yet in 3½ years only enough settlers were obtained to colonize about half the project.

This is a problem that has in no wise been solved by the Delhi experiment, which has rather served to emphasize its importance. One of the fundamental ideas in the original California land settlement act was to give particular attention to these agricultural development costs (as distinct from irrigation development), and by helping finance them for the settler of small means to use state credit in building up successful farming communities.

Delhi was launched under a plan that placed the minimum capital requirement at $1,500 ($1,000 less than at Durham) and this was consistent only in connection with the very liberal loan policy followed at the outset—a policy which later developments made it impossible to continue.

Changes in requirements as to initial capital have been necessitated because of (1) the present policy of the management in advancing loans to settlers and (2) experience that has shown the actual cost of developing Delhi farms under the colonization plan. Those in a position to know best say that if a settler begins now with as little as $2,500 initial capital he would have to be an experienced farmer and would have to arrange his financing very carefully.

About $3,500 to $4,000 is more nearly the average initial capital that was required by settlers who have done well on the project, and among those who have planted to fruit trees the initial capital needed has been about $5,000 for a 26-acre allotment.

Even though Delhi is not being carried out according to the original program, valuable experience on state colonization has been gained from it, and with the aid of the new laws recently passed it is now in a fairly promising condition.

What Happened to Municipal Utilities at Santa Barbara

Water Supply Renewed in 18 Minutes—Shocks Recorded by Water Pressure Gage—Sewers Slightly Affected—Earth Dam Destroyed—City Manager Plan Functions Well

ON June 29, Santa Barbara, a California city of 30,000 population, faced the problem of what to do when all ordinary municipal functions were suddenly paralyzed by earthquakes that not only destroyed structures and utilities but for the time being terrified the populace and more or less disrupted municipal organization. How that organization functioned despite unusual handicaps is well illustrated by the effective precautionary measures and prompt restoration of water, sewer and other utility services. The city manager plan which has long been in effect at Santa Barbara proved to be admirably adapted to emergency measures.

Water Supply—Santa Barbara's water department, trained to the emergencies of fires, broken mains, etc., was the first to function. It lost no time after the first heavy shock that came at 6:42 a.m. Pressure gages as well as the flood in the lower part of the city showed that Sheffield reservoir and the mains from it were out of commission but by closing off this portion of the system and drawing on the supply from another source, Cold Springs tunnel, there was actual interruption of the water supply for only a few minutes.

The water distribution system is well laid out, the city's network being thoroughly interconnected and thus affording convenient means of closing off sections containing breaks without interrupting service over a large area. Excepting the supply lines destroyed by the flood from the Sheffield reservoir only three breaks occurred in important mains; a 12-in. main on State St. was crushed by a falling building, an 8-in. line was ruptured where the earth settled in a fill approaching a bridge, and an 8-in. gate valve was crushed and an adjoining joint pulled out of its socket about 2½ in., apparently where a fault line was crossed. This latter break was in a stretch of pipe running almost due east and west, which is of interest in connection with the reference further on to the overlapping of east and west pavements.

An inspection of Gibraltar dam, which stored the city's water supply on Santa Ynez River, showed no cracks or damage whatever. Caretakers reported a noticeable but not measured increase in stream flow both above and below the reservoir. This is believed to be a temporary condition, the theory being that after long periods seams in rocks are closed by the lime carried by spring waters, thus imprisoning pockets of water which are released when the rock is shaken by a quake. This increased flow was noticed at both the Santa Ynez and Cold Spring sources of the city's supply.

There were fears for the safety of the 4-mile tunnel which brings water through the mountains from the Gibraltar dam. This tunnel traverses various formations and is lined with concrete only in a few short sections. However, instead of closing off the flow through this tunnel the quake actually increased it, probably for the same reasons as those just mentioned. The day before the quake the tunnel delivery was

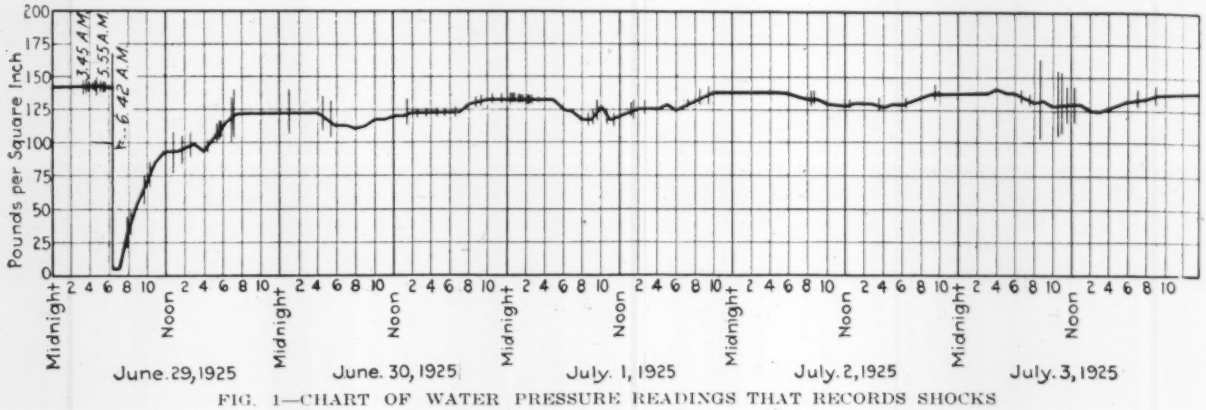


FIG. 1—CHART OF WATER PRESSURE READINGS THAT RECORDS SHOCKS

1,316,547 gal.; on the day after the tunnel flow had approximately doubled (2,640,000 gal.) and 16 days later had decreased again to 2,300,000 gal. daily. Some of this increased flow was due to accretions in the tunnel; though just what this amounted to is not known.

Earthquake Recorded by Meter—An interesting record from the water department is the chart on which pressures in a main supply line are recorded by an integrating meter. This meter has a very sensitive needle and is in a building on soft ground through which vibrations such as earthquake shocks are transmitted readily. The instrument acted as a recording seismograph. The accompanying drawing, based on circular charts taken from this instrument, shows that shocks of small amplitude began to be recorded as early as 3:25 a.m. on the morning of the quake, and continued until 6:42 a.m. when the big shock came that carried away the main and hence reduced the pressure to zero. The same chart shows that at 7 a.m. the pressure began to rise again and by 10 a.m. had been brought up to 75 lb. per sq.in. The chart is continued for the next few days to show the frequency and relative amplitude of earthquakes that followed.

Sheffield reservoir, storing 45,000,000 gal. on the city side of the tunnel, was built near a fault line and the earth dam constituting its southerly end was destroyed at the time of the quake. The destruction, however, occurred in a manner suggesting that the dam was previously weakened by seepage under the cutoff wall.

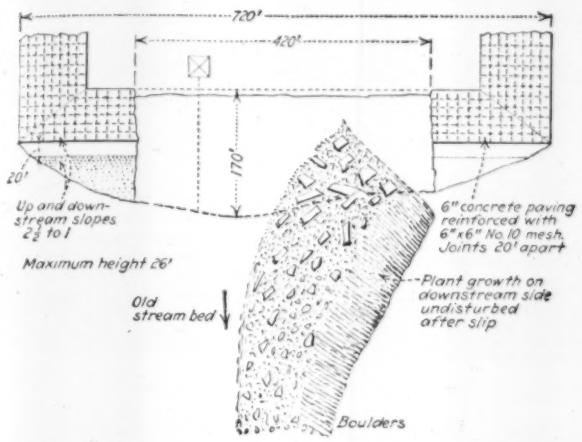


FIG. 2—SKETCH OF SHEFFIELD DAM AFTER BREAK

In fact, leakage had been noted below the dam for some time.

The fact that a large section of the dam moved bodily some 200 ft. downstream, swinging around at an angle with its original position without disturbing the plant growth on the downstream face and leaving a number of slabs of the upstream facing still in position (see accompanying illustration) suggest a horizontal plane of weakness through the structure near its base such as might be caused by saturation. The result is as if it required only the jar of the quake to weaken the dam sufficiently to allow the water pressure to float out the central section, the deeper section starting first and swinging open like a barnyard gate. It is reported that there was no evidence of any considerable water flow in the opening at the hinge end of the "gate," indicating that the reservoir level was lowered before there was opportunity for much escape through this channel.

Sewers—Some sewers were broken in a number of places, but fortunately the old Riensch-Wurl screening plant (*Engineering News-Record*, April 28, 1921, p. 719) was not put out of commission, although built on reclaimed low land where concrete curbs and slabs were crushed all around it. It is to be noted, however, that in this building massive, deeply founded concrete was used as supports for the units, which had to be placed at low level on account of sewer grade.

Some sewer breaks were bypassed, and on one in the lower portion of the city a contractor's portable pumping plant was used to deliver the flow into a line remaining intact. This was all done on June 29. Apparently there were but few breaks in sewer laterals.

The most serious sewer damage (estimated at $60,000) was sustained by the 42-in. concrete outfall, which was nearing completion when the quake came. About 1,000 ft. of this outfall, consisting of 12-ft. lengths, 42 in. in diameter and 6½ in. thick, had been laid. Some 800 ft. of this length has been inspected since the quake and is found off grade in some places as much as 15 in. This disalignment applies even to the submarine section, beyond the shore line, supported on piles. The outer 200 ft. of the submarine line has not been inspected, on account of inflowing sand, but checks made with a transit show that the 900-ft. pile trestle from which the pipe was laid rose uniformly 0.1 ft. while the submerged pipe, also supported on piles, sank as much as 0.5 ft. in some places. The

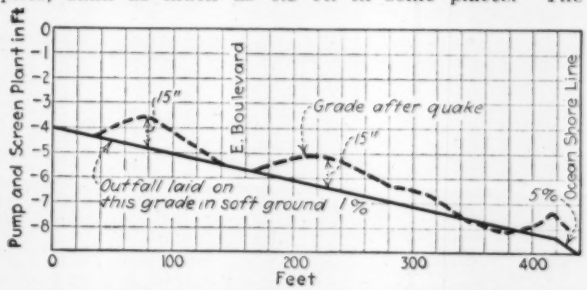


FIG. 4—PROFILE SHOWING WAVES PUT IN GRADE OF OUTFALL SEWER

maximum separation of sections also occurred in this outfall end, where joints came apart as much as 6 in. in at least one point. Considerable portions of the outfall will doubtless require relaying. As shown in the accompanying profile, the entire 42-in. line was raised above grade in an irregular, wavy curve. Except for a short section near the outfall the line was all in open trench at the time of the quake.

Pavement Damage—Generally speaking, pavements throughout the city were practically undamaged. At several points along the boulevard in the southern part of the city, over a blue clay fill along the beach, the entire roadway with asphaltic pavement intact for the most part settled 8 to 10 in., leaving concrete box culverts (supported on piles) standing by that amount above the pavement surface adjoining. Along this pavement the shoulders cracked and settled away, leaving open cracks one to two feet wide and a foot or more in depth where the shoulders should have been.

In this same boulevard there were several places where longitudinal cracks extended for several hundred feet, at some points 4 to 6 in. wide.

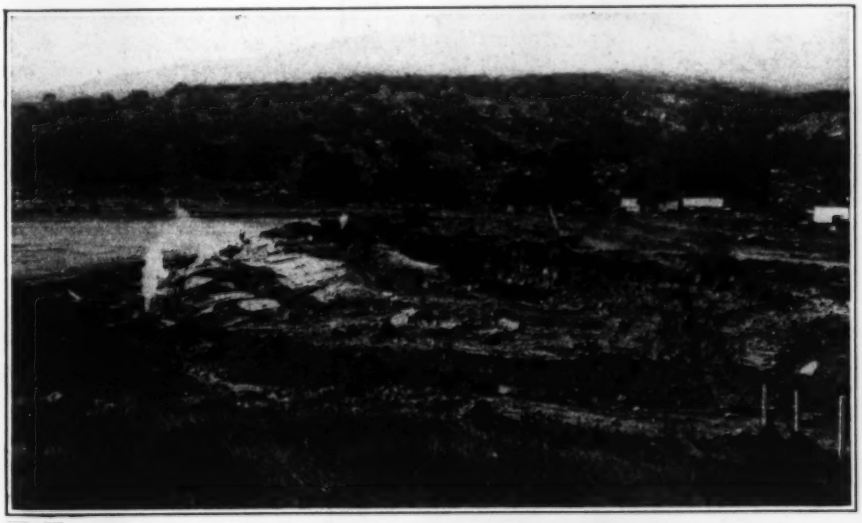


FIG. 3—VIEW UPSTREAM FROM BREAK IN SHEFFIELD DAM
Embankment at left is portion of dam still in place, steam shovel has made cut through foreground. Note slabs on upstream surface.

In contrast to this settlement on the clay fill, the same roadway on solid earth strata only a few feet from the reclaimed land, showed no cracks in pavement nor were shoulders in any way disturbed.

Quite another form of pavement damage, more significant than serious, is the crack across a 16-ft. concrete roadway on the top and toward the southeast end of Mission Ridge. Here, along the line of a slip in a fault plane, one side of an expansion joint remains 2 in. above grade, the eastern end being raised and crushed against the abutting west end. The general direction of the roadway at this point is east and west. Another case of overlapping pavement on an east-and-west roadway occurred some ten miles north of the city, on the state highway, where the east end of the reinforced-concrete pavement at a contraction joint was shoved up and over the abutting end for a distance of 6 in.

Basement Walls—The condition of basement walls after the quake is well summarized by the observation of a local engineer that "most basement walls are cracked, but no good reinforced-concrete basement walls are cracked." This agrees closely with the situation in structures generally, namely, that despite the serious and extensive wreckage, careful check shows well constructed buildings of proper design not to have suffered materially.

FIG. 5—CRACKED PAVEMENT ON RECLAIMED LAND
This is along the ocean, where settlement of roadway occurred and shoulders cracked and settled away from paving.

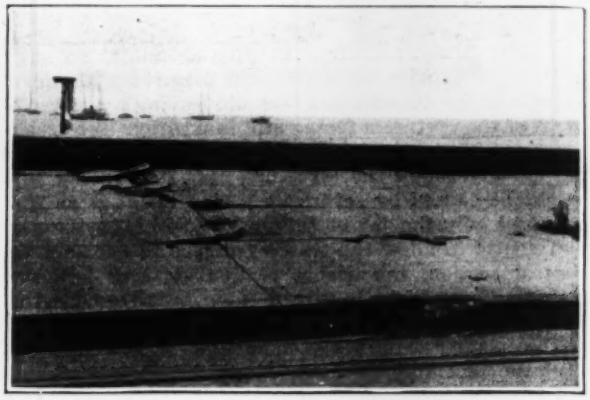


FIG. 6—CURB AND PAVEMENT SPALLING ON SEA WALL
No damage to sea wall was apparent. Sidewalk damage is reported only in a few locations on filled land.

Bridges and Railways—No concrete arches or other bridges of importance have been built in Santa Barbara. Large concrete culverts and short-span girder bridges are practically intact; the wing walls however have cracked or moved away from abutments in some cases. One instance was noted where a wing wall in reclaimed land had tilted out 8 in. or more from the abutment.

Damage to the Southern Pacific R.R., which passes through the lower portion of the city along the waterfront, consisted chiefly of slides and some disalignment which was fixed up so that the line could be open for service again within 24 hours.

Wire Lines—Telephone and telegraph lines were not seriously affected, but damage to the telephone building and consequently to the switchboard, and a similar situation in buildings of the telegraph and the light and power companies, required emergency installations in all three of these utilities which were not completed for some time. Limited wire communication was established the second day but meantime emergency messages were carried by motorcycle and airplane. Perhaps the most notable of these expeditions before wire communication was re-established was that made by Fred Poett, engineer of the water department, to whom City Manager Nunn gives great credit for coolness and efficiency throughout the disaster. Poett volunteered to go to Hollywood for two trucks equipped for operating Klieg lights, which were needed for rescue work in the night following the quake. Poett left Santa Barbara in a navy hydroplane, landed at Santa Monica, and went by automobile 14 miles to Hollywood, whence trucks had to cover 105 miles of highway to return to Santa Barbara. Poett was back in Santa Barbara with the lights 4 hr. 50 min. after leaving.

Soil Conditions—Foundation conditions vary greatly in different parts of the city. There is a section of low reclaimed land in the southern district consisting chiefly of blue clay or adobe and underlain by soft, swampy ground. In this area excessive damage was sustained. Bordering these reclaimed lands is a zone of higher land consisting of gravel, boulders and occasional hardpan. It is in this second zone that the major portion of State St. lies. Aside from the fact that the buildings most subject to quake damage were located along this thoroughfare it is possible that an old ravine long since filled with light material followed approximately the same line as State St. The mesa lands, still higher, have a uniform earth layer ranging up to 80 ft. in depth overlying shale and limestone in place. The solidity of formation and the uniformity of the earth structure in the mesa seem to have prevented the excessive damage sustained in the lower land.

Still another classification of foundation must be made for Mission Ridge, which rises to a height of about 750 ft. and extends for more than a mile across the northeast portion of the city. Parts of Mission Ridge, particularly near the southeast end, where there are indications of fault lines, suffered a more severe shock than even that sustained on the reclaimed land. At least this is indicated by the complete destruction wrought in well built residences of the better class. Mission Ridge consists of large boulders, short sections of rock ledges, adobe and clays interspersed in irregular formations. It is, in short, a conglomerate of earth and rock masses, not "in place." Several old fault lines are believed to exist in the southeast portion of the ridge along which slips have previously occurred. Sheffield

reservoir was built on the side of Mission Ridge away from the city.

Emergency Measures—Remarkable organization work was done by city authorities on the day of the quake and for several days thereafter. Rescue crews were first put to work on the buildings where injured or dead were known to be imprisoned; streets choked with debris were cleared and ready for traffic by noon; motorcycle messengers were sent to neighboring cities to close highways to the curious crowds; marines were brought in to supplement the police; steamers called by wireless were brought to the municipal pier on the afternoon of the quake, where they tied up and remained in readiness to pump water for fires if later quakes should cut off the water supply. Structural engineers were called from San Francisco and Los Angeles to report on the safety of buildings still standing, and sanitary engineers were secured to check the water supply for possible contamination.

In this work particular credit attaches to City Manager Herbert Nunn, an engineer, who was easily the dominant figure in the direction of municipal affairs during the critical period. His leadership was accepted not by virtue of his official capacity so much as because of his obvious ability to take charge of the situation. Mr. Nunn went to the city hall immediately after the quake without even waiting to dress completely, and without once returning home for three days and nights he carried the major burden of responsibility.

Mr. Nunn states that engineers and men with military training were the first to offer their services, and gives special credit to contractors, who worked continuously when no reliefs were available and who generously loaned equipment for rescue work. Highly valued service was rendered by the committee of engineers from San Francisco under the chairmanship of Prof. C. D. Marx, and of a group of architects and contractors from Los Angeles, in the inspection of buildings.

Building Damage at Santa Barbara—Second Report

Details of Earthquake Effect on Important Structures—Principles of Earthquake Action, and Conclusions as to Features of Resistance or Weakness in Different Types of Buildings

By Henry D. Dewell
Consulting Engineer, San Francisco

GENERAL conclusions from a two-day hurried inspection of the damaged buildings in Santa Barbara on July 1 and 2 were presented by the writer in *Engineering News-Record* of July 9, p. 69. As the article was written under pressure of time it could not go into details. The present article discusses in somewhat greater detail the effect of the earthquake on the more important buildings.

Corrections—A few errors in the writer's first article should be corrected at once, and are given below in the order mentioned in the first article.

1. Dr. Willis did not state that the fault line was *in* the Santa Ynez Mountains, but placed it *along the southerly base of the mountains*, running in an easterly and westerly direction, parallel to the coast line, as shown, and approximately 2½ miles north of the coast line. This fault is shown on the Fault Map of California, published by the Seismological Society of America. Secondary or subsidiary faults probably had their influence. Observations of seismologists upon the original and the after shocks show that the movements have been complex, and leave the seismologists in doubt, as yet, as to what part minor faults played in the distribution of intensity.

2. The statement was made that apparently no building with a structural-steel frame existed in Santa Barbara. Further information discloses that this statement is incorrect. The Postoffice Building

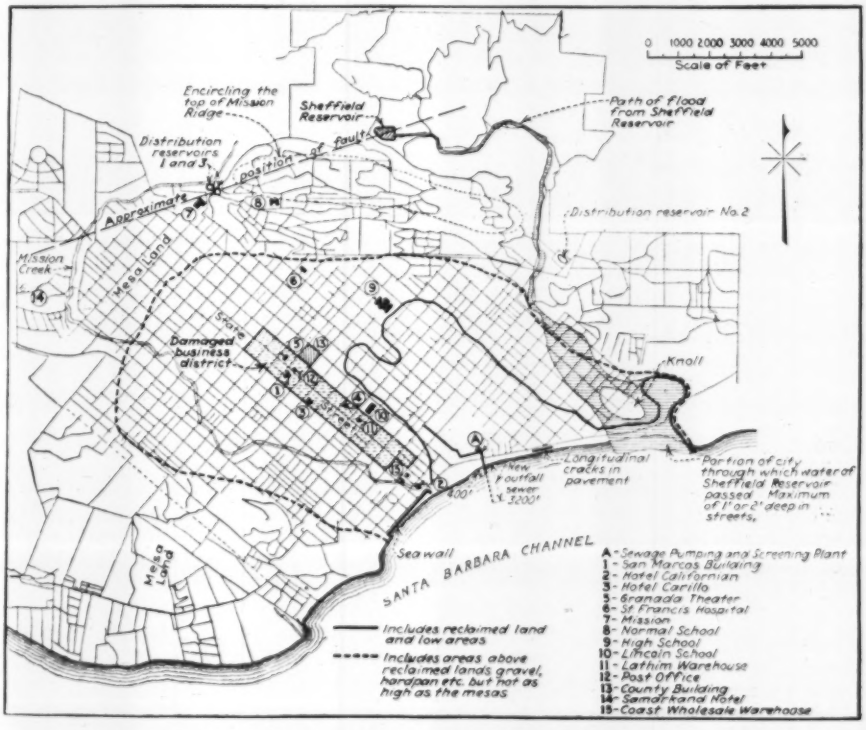

0 1000 2000 3000 4000 5000
Scale of Feet
Encircling the top of Mission Ridge
Sheffield Reservoir
Path of flood from Sheffield Reservoir
Distribution reservoirs 1 and 3
Position of fault
Approximate
Distribution reservoir No. 2
Mission Creek
Mesa Land
Damaged business district
Knoll
New outfall sewer
Longitudinal cracks in pavement
Portion of city through which water of Sheffield Reservoir passed. Maximum of 1' or 2' deep in streets.
Sea wall
SANTA BARBARA CHANNEL
Mesa Land
Includes reclaimed land and low areas
Includes areas above reclaimed lands, gravel, hardpan etc. but not as high as the mesas
A - Sewage Pumping and Screening Plant
1 - San Marcos Building
2 - Hotel Californian
3 - Hotel Carillo
5 - Granada Theater
6 - St Francis Hospital
7 - Mission
8 - Normal School
9 - High School
10 - Lincoln School
11 - Latham Warehouse
12 - Post Office
13 - County Building
14 - Samarkand Hotel
15 - Coast Wholesale Warehouse

FIG. 1—SANTA BARBARA AND VICINITY—LOCATION OF FAULT AND OF WELL-KNOWN STRUCTURES

Drawn for combined reference of this article and the preceding discussion on the city's utilities. No. 4, omitted from list in legend, is the City Hall.

and the Christian Church have steel frames. The walls in both cases are probably self-supporting.

3. The office portion of the Granada Building is 8 (and not 6) stories high, and the theater portion had some structural steel.

Fig. 1 gives a map of Santa Barbara, showing the approximate location of the principal fault line, the position of State St., and the extent of the business district. The direction of the first shock was in general from north to south. This fact has an important bearing on the damage done.

Earthquake Force and Action—It may not be out of place to set forth certain principles that underlie the action of an earthquake on buildings.

The action is that of an oscillating force applied at the base of the building. The mass and the inertia of the building tend to resist this force. The force causing the greatest strains in the building is due to the horizontal component of the acceleration of the earthquake

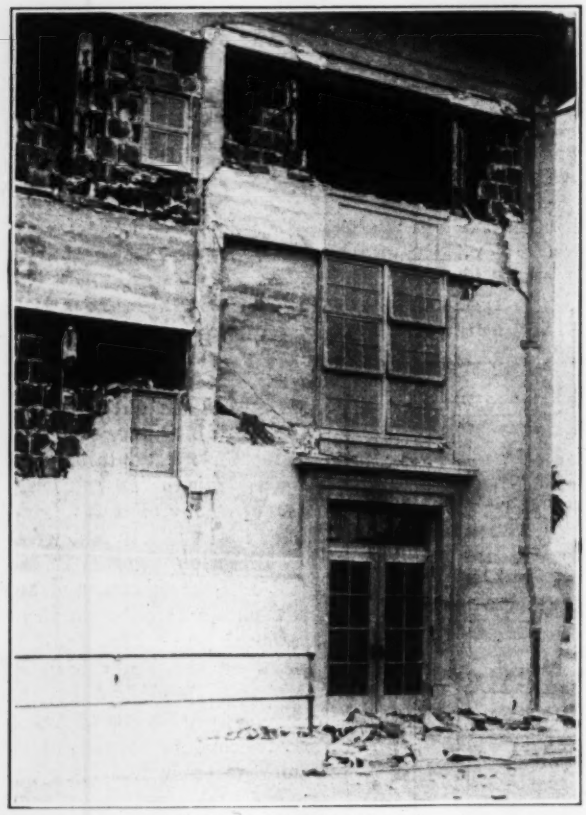


FIG. 2—LINCOLN SCHOOL
Reinforced-concrete frame, terra cotta walls; building standing but quite completely wrecked.

wave, and in amount is the product of the mass of the building and the horizontal acceleration, being thus directly proportional to the weight of the building. The strains which it sets up in the frame of a building with rectangular bays are similar to those set up by wind pressure. There result then specifically:

(a) Horizontal shear in the columns.

(b) Bending in the columns, which is a maximum for any one column at junction of floor girder and column.

(c) Reversal of the bending in floor girders due to the vertical loading of floor loads.

(d) Shear in wall panels, exactly as in the web of a steel plate girder, producing tension and compression respectively, on diagonal planes, and tending to cause diagonal cracking. These "diagonal cracks" are typical of walls which have passed through an earthquake, and may be observed in nearly all of the views reproduced in these articles.

It follows that the force exerted by the earthquake is a maximum in the lower stories of the building.

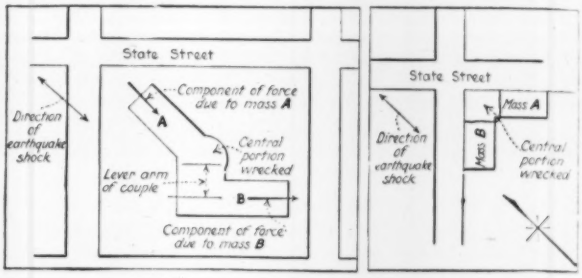


Fig. 3 Fig. 4

FIGS. 3 AND 4—EFFECT OF SHAPE OF BUILDING ON RESISTANCE
Fig. 3, Arlington Hotel, and Fig. 4, San Marcos Building.

Since the first-story columns are usually longer than those above, they may be expected to be affected more than the upper story columns.

Since every structure has a natural elastic vibration period of its own, which in general does not coincide with the period of the earthquake, it follows that if a structure consists of two parts, each having a natural period of vibration materially different from the other, the junction of the two parts is a zone where particular damage may be expected. Accordingly, also, the shape of the plan of the building with relation to the direction from which the shock comes, may affect the forces set up in the building.

Two cases of locality are to be considered. The first is that in which actual displacement of the earth occurs. The second is that in which elastic vibrations alone occur. Any structure built in the first locality will probably be ruptured, the force exerted being commensurate with the resistance offered. Structures may be constructed in the second locality that will resist earthquakes satisfactorily.

Effect of Plan of Building—The influence of shape of ground plan is illustrated by the cases of the Arlington Hotel and the San Marcos Building, Figs. 3 and 4. Note that the shape and distribution of mass of the Arlington Hotel give rise to a couple in the central portions of the building. This undoubtedly had much to do with the destruction of this portion. It is stated that a water tank falling in this portion caused this particular damage. The writer believes that the falling of any tank could have been only partly responsible for the great damage in this portion. A noticeable feature of the damage was the clean stripping of the long steel reinforcing bars, and the absence of stirrups in beams, except near the ends.

In the San Marcos Building, Fig. 4, a component due to Mass A battered the corner portion from a direction parallel to State St., while a second component due to Mass B exerted a similar force parallel to the cross street. The corner portion was unable to resist this intensified force and collapsed. Comment has already been made on the poor appearance of the concrete in this building; apparent excess of water and fine material and absence of coarse aggregate was noticeable. Here, again, the stripping of concrete from beam bars attracts attention. In the writer's opinion, however, this

building, due to its type of construction and absence of provision for resistance to lateral forces, would not have been saved by a better grade of concrete.

Some Details of Damage

The writer presents the following comments by W. L. Huber, consulting engineer, which are of interest and independently bear out the writer's observations and conclusions:

> The Post Office is a steel-framed building. I went over it minutely by the courtesy of the Postmaster and the U. S. Forest Supervisor. It is practically undamaged. A crack in the outside of the pier nearest the street corner is the most evident effect, and this is not serious structurally. A few very minor plaster cracks and a few blocks loosened on the parapet sum up the total damage. There are no cracks of any kind whatsoever in the basement. This is one more example of the superiority of this type of construction for withstanding earthquake shocks.
>
> The experience with reinforced-concrete structures is very interesting indeed. In general the weakness of columns proportioned to resist only direct loads when subjected to heavy shearing stresses is very evident. Banded columns are much less able to stand these shearing stresses than are helically wound columns.
>
> Two interesting buildings, very similar in type and of a type very widely used in recent years, are St. Francis Hospital and Lincoln School. Figs. 2 and 6 show the latter. Both have concrete floors and columns and curtain walls of hollow tile. Both have long spans and consequently deep girders. Neither building is high and neither has heavy live-loading, consequently neither has columns which must support heavy direct loading. The columns of both are small, not heavily reinforced, and banded (not helically wound). In both buildings the columns are very generally and badly sheared directly under the floor girders of the lower stories. Both buildings, while now standing more or less whole, are quite completely wrecked. I have chosen these two buildings as examples because the depth and strength of the concrete girders is out of all proportion to that of the supporting columns. Many other similar examples exist, such as that of the Carillo Hotel and the newer portion of the San Marcos Building, which is still standing.
>
> On the other hand, a study of the Lathim storage warehouse is more reassuring. This is a five-story reinforced-concrete flat-slab building. Since it is used for storage purpose it has heavy columns which are apparently well reinforced with vertical bars helically wound. The 6-in. front and rear walls have typical earthquake cracks in the lower story only. In the rear, particularly, these walls have in one place sheared from the column, but the shear cracks have not gone through the column. The side walls and the upper stories of the front and rear walls are practically undamaged. A couple of the interior columns show slight shear cracks at the base of the heavy capitals under the second floor only.
>
> Another building of flat-slab construction, that of the Coast Wholesale Grocery Co., did not fare as well, although it gave a fair account of itself. The interior columns of this building generally show shear cracks at the base of the heavy capitals under the second floor. The exterior columns are sheared badly at both top and bottom in the first floor.
>
> In my opinion, the most general defect of reinforced-concrete buildings for resisting earthquake effects is the inability of most reinforced columns to withstand shearing stresses. This is particularly true of banded columns. The greatest tendency to shear is at the tops of the first story columns, which are generally the tallest columns. The Hotel Carillo is a striking example of this condition. Every column is badly sheared under the second floor, but practically no damage resulted above the second floor. The frail columns of that part of the reinforced-concrete portion of the Arlington Hotel which is still standing furnish another example.

Granada Theater—This building consists of an 8-story office portion of reinforced concrete, and a theater portion of lesser height having some structural steel, limited, as far as can be determined, to steel roof trusses, steel columns in the side walls, and probably some steel tie beams between columns. The theater portion is practically undamaged, except in the reinforced-concrete east wall, where some spalling and cacking are in evidence. Typical diagonal cracks are in evidence in the plastered exterior face of the southerly wall of the office portion. Whether these cracks extend through the wall itself is unknown yet. On the third floor of this section of the building, one corner column adjacent to the theater portion appears to be sheared away from the building, there being a diagonal crack through the floor. How serious is the damage to this building has not been definitely determined.

Masonic Temple—The Masonic Temple, a reinforced-concrete structure just completed, is three stories high in one portion and two stories high in the remaining portion. A basement extends under the whole building. The first story is to be used for stores, on the second floor are lodge rooms, while the third story contains club rooms. Steel trusses support a concrete roof over the auditorium. As has been mentioned, the first-story front columns were crushed at their junction with the second-floor girders, and some rods buckled. Some concrete partition walls in the first story were buckled, and the rear wall in the lower portion, a 6-in. reinforced-concrete wall, was badly cracked. The engineers of the building, after a careful inspection, state that the actual damage is much less than at first thought, and that all repairs can be made with a cement gun.

City Hall—The City Hall, a three-story reinforced-concrete building, rectangular in plan and of the box type, suffered but a few minor cracks, of no importance structurally.

County Buildings—The county buildings, consisting of the jail, Hall of Records, Court House and Library, all brick and stone buildings, are practically total wrecks.

New Sewage Screen and Pump House—A photograph of the sewage screen and pump house, on the waterfront, was shown in the previous article. The building had terra cotta walls supporting steel roof trusses. The roof was thrown down and the walls shattered.

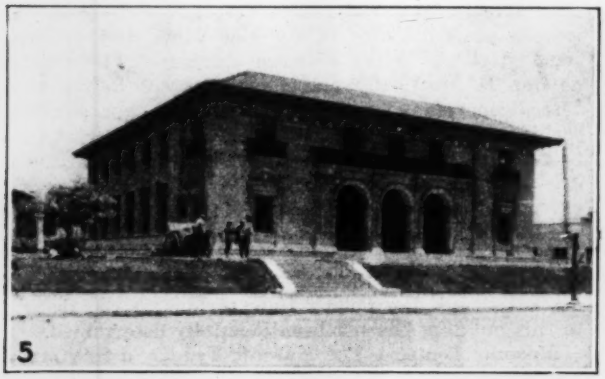
Christian Church—The Christian Church had a steel frame, concrete floors and walls. The building is apparently undamaged except as to chimney.

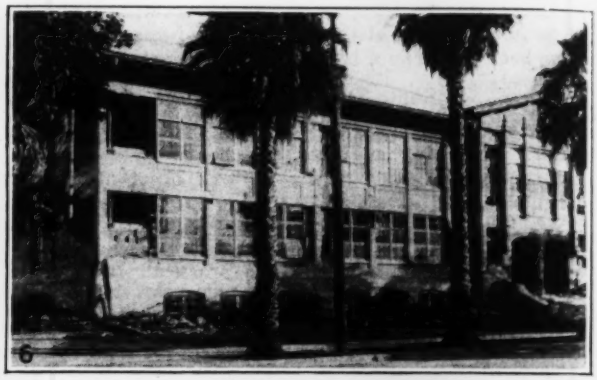
Santa Barbara Mission—The old mission, of adobe construction with walls several feet thick and heavily buttressed, had both towers shattered. The old adobe section in the lower portion withstood the shock well, but along the second-floor corridor large sections of the wall split longitudinally and broke through the floor.

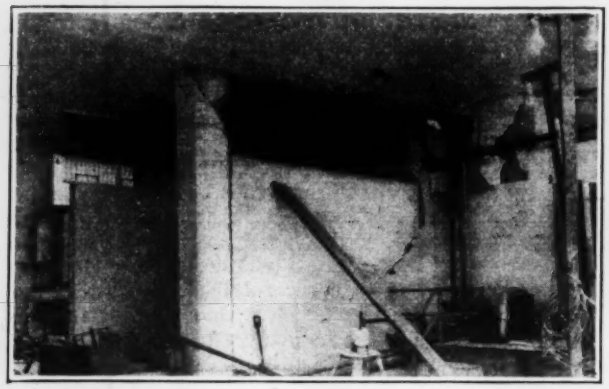
Conclusions

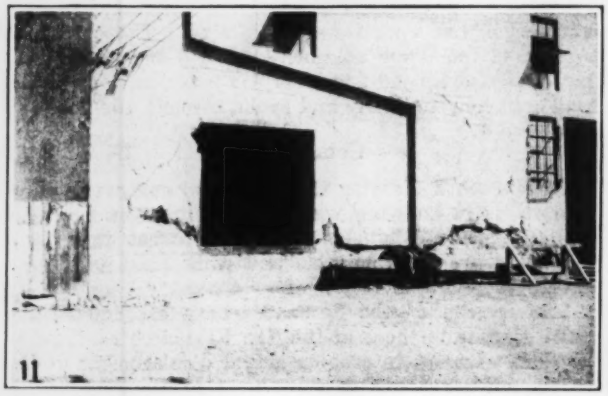
After such a disaster the structural engineer's chief interest is in knowing whether buildings can be made safe against earthquake, and if so, what types and materials are most suitable and what rules of design should be followed.

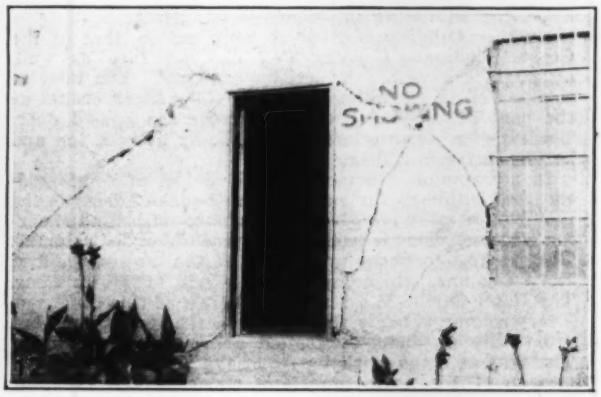
The lessons of the Santa Barbara earthquake are quite similar to those of the San Francisco earthquake in 1906. Except in case of actual displacement of the earth, when rupture of some part of the building is almost certain to occur, buildings can be designed and constructed so that they will withstand earthquakes of the severity of those at Santa Barbara and San Francisco with no material damage.











FIGS. 5 TO 12—IMPORTANT STRUCTURES IN SANTA BARBARA EARTHQUAKE

Fig. 5—Post Office, steel frame, undamaged.
Fig. 6—Lincoln School.
Fig. 7—Partition in San Marcos Building.
Fig. 8—Rear of Carillo Hotel.
Fig. 9—County library, from Post Office roof.
Fig. 10—Stage of Potter Theater.
Fig. 11—Cracks in wall of Lathim Warehouse.
Fig. 12—Effect of door, Lathim Warehouse.

Low frame buildings, as residences, with proper foundations and diagonally braced will come through such earthquakes with probably no greater damage than broken chimneys and cracked plaster. Diagonal bracing and continuous vertical members spell safety.

Masonry Buildings—Brick, stone, cement blocks and hollow tile are unsuitable materials for resistance to earthquakes. Brick buildings, relatively low, of the cellular type, with cross walls well bonded, with first-class masonry, with a plentiful use of cement in the mortar, with band iron in the walls, and floors and roof well anchored by anchors of an efficient design, will probably withstand the earthquake satisfactorily. Parapet walls, cornices and other projections are likely to be thrown down.

Buildings having inclined rafters without sufficient ties, buildings with trusses of the scissors type, will have their walls pushed out by the thrust of rafters and trusses. Such roof construction is obviously unsuitable for resistance to earthquakes.

Concrete Frame Construction—Buildings with reinforced-concrete frame, designed to withstand the lateral forces set up by an earthquake of intensity of the San Francisco and Santa Barbara shakes, will satisfactorily function. An important feature of such a design is that the bending stresses in columns and girders, and particularly the columns, be provided for; that the columns or piers be given sufficient section and be properly reinforced to carry safely the horizontal shear induced, and that all panel walls be designed to take the diagonal tensile and compressive stresses set up in them.

In San Francisco, 6-in. reinforced-concrete curtain walls are allowed by the ordinance if not over 350 sq.ft. in area, as measured by the adjacent columns and wall beams. The minimum reinforcement allowed is $\frac{3}{8}$ in. square bars horizontally and vertically. The spacing of the horizontal bars may be 12 in. while the vertical bars may be spaced at 18-in. centers. Los Angeles requires a minimum thickness of 8 in. with reinforcement in both faces, designed to resist at working unit stresses a lateral pressure of 30 lb. per sq.ft. The writer is inclined to believe, from his observations of concrete walls in Santa Barbara, that the Los Angeles provisions are the minimum that should be allowed.

In the design of reinforced-concrete columns and piers, it should be pointed out that the use of gussets or capitals at the junction of column and girder does not strengthen the column for resistance to shear, as the horizontal shear is constant throughout the column length of any one story. If, however, the column, at its junction with a girder, is weak in bending, and fracture occurs, the section of the column for resistance to shear is automatically reduced. In the case of the reinforced-concrete buildings in Santa Barbara that exhibited fracture of the columns at the junction of floor girders, such fracture probably was due to a combination of shear and bending. It is hardly necessary to point out that cross walls, integrally cast with the columns, of proper thickness and with proper reinforcing, are a very desirable feature, and will provide the needed resistance.

Steel Frame—Steel columns and girders have a distinct advantage over reinforced concrete in this respect. The steel column can stand practically as much shear as direct load, in sharp distinction with the reinforced-concrete columns. The connection of column and girder must of course, be designed to withstand the bending at such junction.

Study in Progress—It may be of interest to engineers to know that the Seismological Society of America has organized a committee on building for safety against earthquakes, composed of representatives from this society, the American Society of Civil Engineers, the American Institute of Architects, the National Board of Fire Underwriters, and the cities of San Francisco and Los Angeles, the writer representing the American Society of Civil Engineers.

Using the "Fault Map of California" published by the Seismological Society, the committee has formulated tables giving the probable horizontal acceleration of earthquakes to be expected, based on observations and studies made after the San Francisco earthquake of 1906, and expressed in terms of the intensities by the Rossi-Forel scale, the distance from known fault lines, and the character of the underlying soil. Recommendations are being formulated for proper types of construction for buildings and for proper methods of design for buildings which may have to resist earthquakes. The results, while not exact, will assist materially in enabling structures to be so built that safety against probable earthquakes may be reasonably assured.

In conclusion, the writer wishes to express his appreciation to W. L. Huber, for permission to make use of his observations and comments, and to reproduce his excellent photographs, and also to E. M. Knapik, his assistant engineer, for information.

Flood Protection Studies for Syracuse

Flood possibilities and feasible methods of protection from floods at Syracuse, N .Y., are to be studied by the Syracuse Intercepting Sewer Board, Glenn D. Holmes, chief engineer. This study was made possible by a law passed by the state legislature last spring, enlarging the scope of the board's duties to include flood studies. The legislation, in turn, followed active local agitation among engineers assisted by newspapers and other civic institutions, basing on the discussion of the local flood danger held at a meeting of the Syracuse Section of the American Society of Civil Engineers last February. Recorded flood volumes in Onondaga Creek at Syracuse have steadily increased with the length of record. The flood of December, 1901, with 3,500 sec.-ft., was the greatest measured at the time of its occurrence, but it was exceeded in 1914 (3,600 sec.-ft.), 1915 (5,500 sec.-ft.), 1920 (6,000 sec.-ft.), and 1925 (5,500 sec.-ft.). The maximum flood to date, that of 1920, was due to a combination of warm weather, rain for several days, and a large depth of snow on the ground. However, it is believed that cloudburst rainfalls may produce very dangerous floods. An unusual factor of the problem is that the possibilities of channel enlargement within the city are so restricted that probably it is not possible to obtain sufficient capacity for the probable flood flows at feasible cost, and control or detention works upstream may have to be considered.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Chicago's Emergency Men Remained on Duty

Sir—On behalf of the members of the Engineering Employees' Association of the City of Chicago, we wish to thank you for your article headed "Chicago Technical Staff Suspends Work for Half Day," in *Engineering News-Record* of July 9, p. 78.

As noted in your article, our action was designed not to tie up any city activity but to call the attention of the City Council to the neglect accorded our requests. We are particularly pleased at your notice of the fact that men in vital or emergency positions were ordered to remain at their posts. *Engineering News-Record* has always given our problems fair and comprehensive treatment and we wish to take this opportunity to express our appreciation.

ARTHUR SULLIVAN, President,
L. M. BOLGER, Secretary,
Engineering Employees' Association of City of Chicago.

Chicago, Ill.
July 16, 1925.

Variable Cement Tests

Sir—Your editorial entitled "Commendable Curiosity" which appeared in your July 9, 1925, issue and which comments on A. T. Goldbeck's paper before the A.S.T.M. is also commendable and is a timely warning that there is something wrong with our present methods of testing cement.

The consulting engineer rarely concerns himself with actual cement testing but must leave that work to well equipped testing laboratories. He is, however, continually confronted with results of tests upon which his decision must rest whether the cement is satisfactory or must be rejected and here arise many annoying instances caused either by the vagaries of the test methods or of the cement itself.

Doubtless, the files of many consulting engineers, if scrutinized, would reveal innumerable cases which would show that the doubt as to the reliability of cement testing is not confined to a few specialists in that art but is really widespread.

Two very annoying instances have arisen in our recent practice. In the first, a standard brand of cement was being used on one of our bridges. One day the resident engineer reported that a new carload of this brand of cement had a decidedly darker color than cement which had previously been used. Investigation disclosed that this dark cement had passed the A.S.T.M. tests and yet there must have been some lack of uniformity to cause the decided color change. A chemical analysis of it was very little different from a similar analysis of the lighter cement except that the loss of ignition for the latter was nearly twice that of the former. We have never had an explanation of the cause of this difference of color. The testing laboratory confined itself to the following remark: "The usual ingredient to which color is due is iron oxide. This is practically identical in percentage in both the light and the dark colored cements which we have examined. The other two contributing causes, in general, are seasoning of the clinker before grinding and excessive watering of the clinker while hot."

A second example occurred in connection with another large bridge. A sample of sand was sent to the laboratory for the usual tests. At the end of 3 days, the tension briquet test showed 80 lb. as compared with Ottawa sand at 138 lb. At 7 days, the tensile strength was 140 as compared with Ottawa at 232. From such report, one's first impulse would be to reject the sand which had been proposed for the work. If that had been done it would have caused a considerable and unwarranted monetary loss to the contractor because there was no other available local sand and it would have been necessary to ship sand from some distant point. All other properties of the sand being satisfactory, another sample was sent to a second laboratory which reported 113 and 185 lb. for the 3 and 7-day tests respectively as compared with 111 and 191 for Ottawa sand.

It was then discovered that the two laboratories had used two different standard brands of portland cement and, thereupon, the first laboratory was requested to repeat the tests using that cement employed by the second laboratory. The results were as follows for the 3, 7 and 28-day periods, 142, 207 and 270, while the corresponding results for Ottawa were 150, 212 and 303. As a check, 2-in. cubes were made for compression tests and showed a compression strength per square inch of 744, 1,375 and 1,887 lb. for the 3, 7 and 28-day periods, as compared with 702, 1,372 and 1,895 lb. for Ottawa sand.

The only explanation we could obtain was "that different cements react differently when used with the same sand." Yet both laboratories assured us that the cements had been carefully tested and had passed the A.S.T.M. requirements.

Private discussion of this question has elicited the opinion of several engineers that, after all, cement tests mean very little. Engineers accept cement, which has passed the A.S.T.M. requirements, implicitly and not because they have any definite faith in such tests. They feel that there is nothing better to offer them in the matter of tests and that, perhaps after all, such tests do indicate that the cement just purchased is like the previous shipment received from the same mill.

CONCRETE STEEL ENGINEERING COMPANY,
William Mueser.

New York,
July 11, 1925.

Preventing Undercutting of Dams

Sir—In your issue of May 21, p. 866 appears a letter from M. Suquet of Paris, France, discussing the article of A. F. Meyer in the April 9 issue on the design of dams to prevent erosion. In deducing the parabolic formula for the shape of the sheet of water passing over a dam M. Suquet assumes a, the drop or head producing velocity, as $\frac{2}{3}$ of b, the head above the crest of the dam.

Now the theoretical maximum discharge over a broad crested weir occurs when the depth of water on the weir is $\frac{2}{3}$ of the head above the crest. Is not this what M. Suquet has in mind and hence instead of taking $a = \frac{2}{3}b$ should he not use $a = \frac{1}{3}b$ and make his resulting equation $4by = 3x^2$ instead of $8by = 3x^2$? If my assumption is in error I would like to know the basis for assuming $a = \frac{2}{3}b$.

D. E. EASON,
Superintending Engineer, Trent Canal Department of Railways and Canals.

Peterboro, Ont., Canada,
June 9, 1925.

[This letter was submitted to M. Suquet who has replied as follows.—EDITOR.]

Sir—In response to your letter of June 12 forwarding to me a copy of a letter from D. E. Easton, I have the honor to advise you that the observation which he has made is perfectly justified. The formula should read

$$a = \frac{b}{3}$$

$$4by = 3x^2$$

M. SUQUET.

Paris, France.
June 20, 1925.

Population Estimates of Largest Cities

Census Bureau estimates of the populations of 54 of the larger cities of the United States, have been announced as of July 1. They give New York as having 6,103,384 people; Chicago, 2,995,239; Philadelphia, 1,979,364; St. Louis, 821,853; Baltimore, 796,296; Boston, 783,166; Pittsburgh, 631,563. Estimates for Detroit, Cleveland and Los Angeles, which in 1920 stood fourth, fifth and tenth in population, are not attempted because of lack of data.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Railroad Attempts to Stop Reservoir Construction

Hudson River Regulating District Attacked—Conspiracy Alleged

On the eve of the contemplated sale by the New York State Comptroller of $2,000,000 bonds for construction of the Sacandaga reservoir by the Hudson River Regulating District, attorneys for the Fonda, Johnstown and Gloversville R.R. have instituted an action in the supreme court in Fulton County attacking the constitutionality of article VII-A of the state conservation law, which authorizes the creation of river regulating districts, and charging that certain power and paper companies on the Hudson River entered into an unlawful agreement to have filed with the state water control commission a petition for the establishment of the Hudson River Regulating District, ostensibly for the purpose of controlling the flow of river within the district, but in reality to construct and create the Conklingville dam and Sacandaga reservoir to impound water for power generation for their private gain.

The railroad company asserts that 8 miles of its track would be taken, which would be the equivalent to an abandonment of its property in the section and impair its ability to perform as a common carrier of persons and property.

The secretary of the Hudson River Regulating District in an interview regarding the action said:

"The summons and complaint served on the board speaks for itself and is the culmination of a threat that was made in Dec., 1923, by attorneys for the Fonda, Johnstown and Gloversville R.R., that they would attempt to force the board to pay more than a million dollars for about seven miles of their branch railroad. This project was conceived more than 20 years ago and was first extensively investigated in 1907, at the request of Governor Hughes. After receiving the preliminary report, he urged its construction in order to prevent floods and to increase the development of the natural economic resources of the state along the Hudson River. Since that time studies and investigations by various state departments have only served to accentuate the economic soundness of the project.

"The board has set aside in its estimate something more than $2,300,000 for the acquisition of lands upon which to construct the Sacandaga reservoir, and included an item of $400,000 for the relocation of the F. J. & G. R.R. It has been the policy of the board to attempt to pay for damages for the relocation of highways and railways, by negotiation with the owners. This policy was pursued in the case of the F. J. & G. R.R. After an exhaustive study by its engineers, the board made an offer of $550,000 to the railroad company for the relocation of its roads and the acquisition of the lands. Since the Fonda, Johnstown and Gloversville R.R. company declined to accept the offer of the board, made in January of this year, and asked for the exorbitant sum of more than four million dollars, the board filed notice of appropriation and condemnation on the railroad company on April 17, 1925. The fact that the railroad company took no action on this notice of appropriation until a few days before the first issue of bonds is to be sold, speaks for itself."

Probably as a result of this action on the part of the F. J. & G. R.R. no bids were made for the bonds when they were offered by the state controller on July 21. The controller had announced previously that no conditional bids should be accepted.

Engineering Fifty Years Ago

From *Engineering News*, July, 1875

RAILROAD construction seems to be in a bad way the world over. The recent report of the British Board of Trade of the exports for the first half of the year show that 259,307 tons of railroad iron of all kinds were exported in 1875, against 427,297 tons in 1874. The exports last year were sufficient to lay 4,805 miles of track with 56-lb. iron; those of this year, only enough for 2,947 miles, or 1,858 miles less. Roughly speaking, the exports of this year were about sufficient for the maintenance of 40,000 miles of ordinary iron track during the half year.

All this is evidence that the suspension of railroad construction has been general, and not confined to the United States alone. Of course England is not the only manufacturer of rails, but it is by far the greatest *exporter* of rails, and its exports are a pretty good clue to the activity in construction in countries which do not produce rails. For the last half year no country has taken rails enough to make 500 miles of road, which would hardly leave any margin for new construction in a country with 3,000 miles of railroad to maintain carrying a considerable traffic.

Large Paper Mill for Manitoba

The Spanish River Pulp & Paper Co. in conjunction with the J. D. McArthur interests is reported to be planning to build a 200-ton paper mill at Fort Alexander, Manitoba, at a cost of $4,500,000. The Canadian National Railway has agreed to build a spur from its line to the site of the mill.

Railway Congress Meets in London

Tenth International Congress Held in Conjunction With British Centenary

The International Railway Congress, which resumed its sessions after the war by meeting at Rome in 1922, met this year in London, England, instead of Madrid, Spain, in 1927, as originally planned, in order that the delegates might take part in the celebration of the 100th anniversary of railroad operation in England, the opening of the Stockton & Darlington Ry. in 1825.

The congress was opened on June 22 by the Duke of York and continued in session until July 2. Part of this time was given over to inspection and pleasure trips, to receptions and banquets.

The papers which were presented have been published in the *Bulletin* of the International Railway Congress and are available in English in the English edition of the *Bulletin*. The unusual feature of this congress in-so-far as the delegates from America and the British colonies were concerned was that a large part of the discussion was in English. It is unfortunate, therefore, that so few American railway men were present; the total delegation numbering only about forty.

Nothing unusual was brought out in any of the papers or in the discussion, but as the Duke of York said in his opening address "Conferences such as these provide an opportunity for the representatives of every nation to meet on a common ground, to get to know each other better and to appreciate each other's point of view." In this respect the congress was worth while.

Subjects of special interest to civil engineers in railway work were the discussions on hump yards under the general subject of "Shunting Yards", and of gages in the session on light railways, also the papers and discussion under the subjects of maintenance of track and level crossings. Reports on both these subjects were presented by G. J. Ray, chief engineer of the Lackawanna. J. H. Parmelee of the Bureau of Railway Economics in Washington was appointed chairman of section IV, General, and presided at the session on railway statistics. The session at which breakage of rails was discussed was of particular interest because the problem is common to all railroads. W. C. Cushing, engineer of standards for the Pennsylvania presented the American report on this subject.

On the subject of suburban railways much common ground also was found although the equipment and physical conditions vary in different countries.

The technical sessions closed in time for the delegates to go to Darlington for the centenary celebration.

City of Baltimore Reorganizes Its Engineering Departments

Complete reorganization of the municipal engineering departments of Baltimore will be brought about under the provisions of an ordinance passed by the City Council and signed by Mayor Howard W. Jackson last week. It creates the Department of Public Works, headed by a chief engineer, under which ten bureaus will operate. The mayor also has announced the appointment of those who will head the department and the bureaus.

Bernard L. Crozier, for two years highways engineer of Baltimore, has been designated chief engineer of the Department of Public Works. Mr. Crozier, who is 38 years of age, is a graduate of the Baltimore public schools and of the Alabama Polytechnic Institute, where he received his engineering training. He also is a member of the bar. The ordinance provides that the chief engineer be a member of the Board of Estimates. This board also is given power to fix the salaries of the new officials.

Steuart Purcell, who has served as chief engineer of the city for the last two years, was appointed head of the Bureau of Highways.

V. Bernard Siems, water engineer and president of the Water Board for the past two years, will head the Bureau of Water Supply. Mr. Siems has been connected with the city government since leaving college. He served as principal assistant water engineer before he became water engineer.

Milton J. Ruark, at present head of the Sewer Division of the Highways Department, will be the head of the Bureau of Sewers. He has been connected with the city for about 25 years and was with the Sewerage Commission, under which the storm-water and sanitary system was constructed.

Francis W. McKinney, named to head the Bureau of Harbors, was engineer for the Commissioners for Opening Streets for a number of years. About two years ago he was appointed assistant harbor engineer and became acting harbor engineer when Bancroft Hill resigned from that position about a year ago.

Charles F. Goob at present at the head of the electrical division and who at one time served as highways engineer, was appointed head of the new Bureau of Mechanical-Electrical Service.

Charles H. Osborne, inspector of buildings, heads the Bureau of Buildings. He has served as an engineer in the department he now heads.

Joseph W. Shirley, chief engineer of the Topographical Survey and chairman of the City Planning Commission, becomes head of the Bureau of Plans and Surveys.

Conrad Zieget, Jr., chief of the municipal laboratory, was appointed head of the Bureau of Standards.

Oscar F. Lackey, who served as harbor engineer of Baltimore for a number of years during a previous administration, was named head of the Bureau of Transportation. For the last few years he has been engaged in outside engineering work.

William A. Larkins, who has served as commissioner of street cleaning during several admininstrations and is holding that office at present, was designated head of the Bureau of Street Cleaning.

The reorganization, which was recommended by Mayor Jackson's Commission on Efficiency and Economy (see *Engineering News-Record*, Jan. 22, 1925, p. 147 and editorial comment, p. 138) will abolish a number of commissions and boards. These include the Electrical Commission, Harbor Board, Paving Commission, Water Board and Topographical Survey Commission. The work of these departments will be taken over by the Department of Public Works.

George T. Ames, at present superintendent of buildings, will become deputy in charge of public buildings under the Bureau of Buildings and H. Walter Johenning, now chief of the Bureau of Minor Privileges, will become deputy in charge of minor privileges in the Bureau of Buildings. William A. Parr, who is superintendent of lamps and lighting, will become deputy in charge of lamps and lighting in the Bureau of Mechanical-Electrical Service. Samuel T. Griffith, at present chief inspector of weights and measures, will be connected with the Bureau of Standards, which will take over the duties of this department.

Edward J. Hecker, city surveyor, who was elected by the people, is placed in the Bureau of Plans and Surveys under the provisions of the ordinance.

It is expected that the new Department of Public Works will begin to function on Aug. 1. Plans also are under way to make adjustments in the salary list. This will be in the hands of the Board of Estimates, which will make provision for increases in the budget for 1926.

Colors for Traffic Signals

The American Engineering Standards Committee has about completed its work on the standardization of traffic signals and the code is about to be published.

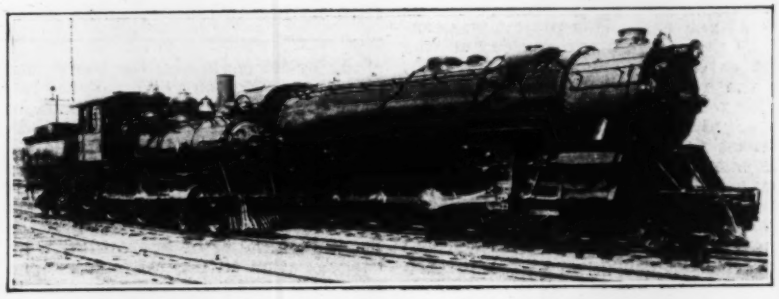
Administration of Washington, D. C. Building & Parks Attacked

Representative Thomas L. Blanton, in an open letter to Col. Clarence O. Sherrill, published in the form of a 27 page pamphlet, attacks the administration of the department of Public Buildings & Parks in Washington, D. C., under Col. Sherrill. The greater part of the pamphlet is given over to the details of reported irregularities in Park Police, a police force reporting to Col. Sherrill and independent of the Metropolitan police and having separate police courts. The remainder of the letter contains an attack on the way in which park and other concessions are granted by the superintendent with little or no return to the government, and upon a provision, written into the new traffic code for the district, which delegates the regulation of all traffic within the public parks to the superintendent of Buildings & Parks. The letter also contains a general attack upon the Corps of Engineers for the high cost of all work which it has undertaken, including the dam at Muscle Shoals and bridges at Washington.

Since the letter was made public Col. Sherrill has stated that he would not make a categorical reply to the charges; that he would prefer to leave the issue to the findings of an investigating committee should Congress see fit to appoint one to investigate the charges.

Ore Pier at Superior, Wis. to Be Extended

The Northern Pacific Railroad Company has announced that it intends to build an addition to the company's iron ore pier located at Superior, Wis. by building an extension 648 ft. long and containing 108 pockets. This will give the pier an overall length of 1,848 ft. with 310 pockets and a storage capacity of 108,500 tons of ore. It is reported that the extension will be built of reinforced concrete at an estimated cost of $800,000. Work will start some time this fall.



Largest Passenger Locomotive in the World

Recently, the Baltimore & Ohio Railroad Company completed at its Mount Clare shop what is reported to be the largest passenger locomotive in the world. It was designed and built entirely by the forces of the B. & O. Railroad, 30 working days being required for its construction. The total weight of the locomotive and tender is 659,000 pounds and the total weight on the drivers 275,000 pounds. The length overall is 100 ft. 6 inches. The rated tractive power is 65,000 pounds and the factor of adhesion is 4.23.

In the photograph reproduced above the new locomotive is compared with one built in 1890 by the company's own forces at the Mount Clare shops.

Misuse of Data Alleged in Cement and Flooring Rehearing Plea

In its petitions for rehearing filed in the Supreme Court in the cases of the Maple Flooring Manufacturers Association and the Cement Manufacturers Protective Association, the Department of Justice accepts the principle laid down by the Court in its decisions in May that the collection and distribution of trade statistics are not illegal acts of themselves, but set forth the argument that the defendants went outside this principle and committed specific acts which were violations of the law.

In the cement case, the Government's petition declares: "The plan of the defendant association is the most adroit and comprehensive that has been brought to the attention of the Department of Justice." The defendants not only used but "misused" the information gathered, it is contended, and "have succeeded in placing prices not merely on an approximate level, but on a dead line of uniformity." This uniformity, says the petition, is not the result of free competition, but furnishes "proof of nothing save of a guilty purpose carried to its successful end."

In the Maple Flooring case, the petition asserts that:

"The evidence relating to prior activities of the defendants was competent to prove and did prove the unlawful objects of the present association;

"The computation and distribution among the members of the Association of the so-called 'average cost' list could have no reasonable relation to any legitimate object, since the 'average costs' are nobody's costs;

"The distribution of the total 'average cost' among the several sizes and grades of flooring is purley arbitrary and can have no possible purpose other than to establish minimum prices."

According to the petition the purpose of information as to freight rates was to facilitate establishment of uniform delivered prices.

New Legislation in California Affecting Engineering Work

The Governor of California has approved the recently passed measure appropriating $150,000 for continuing investigations of surface and underground water supplies which have been carried on for several years by the State Department of Engineering under appropriations made by successive legislatures. Three bills vetoed by the Governor were: (1) The measure raising the gasoline tax from 2 to 3c. per gal. to provide more road funds; (2) the bill appropriating $419,000 for work on a deep-water ship canal to Stockton, and (3) the bill proposing to transfer San Francisco harbor control from the State Board of Harbor Commissioners to the City of San Francisco.

In Los Angeles on June 2 the voters overwhelmingly approved two bond issues totaling $10,000,000, of which $2,000,000 is for preliminary work on the proposed Colorado River water supply project and $8,000,000 for extensions of the present water system, as noted in *Engineering News-Record*, May 28, p. 910.

State Highway Officials to Meet Late in November

The date of the annual meeting of the Association of State Highway Officials has been fixed so that those in attendance may have the advantage of a first hand account of the International Highway Conference at Buenos Aires. The association will meet in Detroit, Nov. 18, 19, and 20. By arranging to hold the meeting somewhat later than is customary, it will permit of the attendance of Mr. MacDonald, who will proceed to Detroit immediately on landing.

One of the features of the Detroit meeting will be displays of motorized equipment used in road building. For that reason most of the state highway commissions are arranging for the attendance of the members of their staff in charge of mechanical facilities.

Deep Subway for N. Y. Surburban Traffic Proposed

A suburban rapid transit subway plan prepared for the Westchester County Transit Commission was presented at a recent hearing before the New York State Suburban Transit Commission, a commission appointed by the state legislature to study the suburban rapid transit situation at New York. The plan calls for a subway which will gather in the lines of the New York Central, the New York, New Haven & Hartford and the New York, Westchester & Boston railroads above the Harlem River, cross under the river to Manhattan Island run in a deep tunnel under Madison Avenue to Madison Square, then under Fifth Avenue and West Broadway to the neighborhood of the City Hall. Such a tunnel would be in rock for the greater part of the way as it is proposed to keep it at such a depth as to permit of building a two-level subway above it in the streets traversed. The proposed subway for the Westchester County traffic will also be a two-level four-track subway with only three stations on Manhattan Island, tentatively located at 125th St., 42d St. and in the neighborhood of the City Hall.

The uptown stations would be at a depth of about 60 ft. below street level, and the downtown station about 135 ft. or approximately the same depth as the present Broadway subway station at 191st St. This station would be made in two loops with long platforms and numerous large passenger elevators and is designed to separate north and south bound traffic.

The scope of the study did not include extension of the subway to New Jersey, but the engineers point out that an extension under the Hudson River to the Jersey Central terminal would be a logical arrangement on account of the southerly location of that terminal and would provide traffic in the reverse direction by a route that would be very advantageous to the passengers for the mid-town section of New York.

The estimated cost of the subway is $150,000,000. The plan was prepared by Henry M. Brinkerhoff of the firm of Parsons, Klapp, Brinkerhoff & Douglas, New York.

Ontario Hydro Commission Reports Favorable Year

The annual report of the Ontario Hydro-Electric Power Commission for the fiscal year ending Oct. 31, 1924 states that it was the most successful year in the history of the commission. The total revenue from the sale of power was $16,897,866, and the total expenditure $16,172,158, including an appropriation to the reserve of $3,094,155, leaving a surplus at the close of the year of $725,708. The total investments of the commission in power undertakings and electric railways amounted to $190,027,909, and the investments of municipalities served by the commission in distributing systems and other assets amounted to $72,753,596 making a total capitalization of $262,781,505.

Of the 386 municipalities and industrial corporations supplied directly by the commission 39 now hold quick assets which more than counterbalance the liabilities incurred in connection with their electrical utilities. A reduction in charges has been made to 122 of the 142 rural townships served by the system. The commission has expended about $2,700,000 to supply service to 10,800 rural consumers and has constructed approximately 1,400 miles of transmission lines in connection with this department.

Giant Survey Board Reappointed by Governor Pinchot

Governor Pinchot of Pennsylvania has appointed a new Giant Power Survey Board to take the place of the original board which went out of existence through the failure of the last general assembly of Pennsylvania to enact a bill providing for its continuance. All the legislation recommended by the former board died in committee.

Morris L. Cooke, who was director of the former survey, will continue in that position with the new board.

Court Decision Affects Manager Project at Rochester, N. Y.

The recent court decision invalidating the home rule amendment to the constitution of New York State will postpone, and if sustained on appeal will nullify, the attempts in progress to adopt the city manager plan at Rochester, N. Y. A manager-plan campaign has been in progress for some weeks, a manager charter has been drafted and was before the city council when the home rule amendment was declared invalid.

Boston & Maine R.R. Inaugurates Novel Bus Service

The Boston and Maine Railroad Company is now running a motor bus service from Boston, Mass., to Portland, Maine, a distance of a little over 100 miles, which it supplements by a free taxicab service in Boston. Passengers leaving Boston are called for by taxicabs free of charge at any point within two miles of North Station, and upon returning are sent by taxicab to points within the same area without charge. Buses make regular trips each way both morning and afternoon, daily.

WASHINGTON NOTES

Proposed routes for a Great Lakes-to-Hudson waterway probably will be inspected in the near future by the board of engineers which will report on the project. The board is considering the Lake Erie-Lake Ontario route, the La Salle-Lewiston route and the Tonawanda-Olcott route as alternatives for the Canadian Welland canal route. Two routes are being considered from Lake Ontario. One is that by way of Oswego and the present New York state barge canal. The other is St. Lawrence-Lake Champlain route. The board is revising the estimates made by the Ernst board in 1900.

Structures in the navigable waters of the country continuously are being erected without a War Department permit, as required by law. For the most part these structures do not interfere with navigation and occasion no complaint from the Corps of Engineers, as it is recognized that the requirement was not understood. The serious feature in connection with these illegal structures is that a special act of Congress is required to legalize them. The law has been contrued as giving no authority for the issuance of a permit after the erection of the structure.

Since the structure has no legal right to be occupying a place in the navigable waters of the nation, it occasions a high degree of responsibility on the part of the owner in case it is the cause of damage to shipping.

The acting Secretary of War has approved a plan for increasing the height of dam No. 41 in the Ohio River at Louisville. This will make possible the development of 350,000,000 kw.-hr. of electricity annually and will simplify the navigation improvement. The power project will be handled by the Louisville Hydro-Electric Co., which plans to install machinery sufficient to generate 100,000 hp. The hydro development will cost $7,500,000, the company estimates. Power will be available late in 1928 or early in 1929, it is expected.

The dam will be built by the Corps of Engineers. By raising the crest of the Louisville dam 41 ft. the need for a navigation dam at Madison, Ind., fifty miles upstream is eliminated.

The engineering firm of Viele, Blackwell and Buck of New York, has been retained in a consulting capacity by the American members of the Joint Engineering Board for the St. Lawrence. The firm will make certain studies in connection with the hydro-electric possibilities of the stream.

The people of the Fox River Valley, in Wisconsin, were the first to place money at the disposal of the Corps of Engineers for the pro ecution of work prior to appropriation of federal funds, as provided in the act authorizing various river and harbor projects. The deepening of the navigation channel at Depere was authorized at the last session. The improvement would have been delayed a year had it been necessary to wait for the actual appropriation of federal funds. The amount advanced the Corps of Engineers will be returned as soon as the appropriation is voted.

Los Angeles also is taking advantage of that feature of the act and is going ahead with its breakwater plans, but no portion of the fund for the federal part of the work yet has been made available.

The same is true of the Intracoastal Canal project in Louisiana and Texas, authorized by the same bill. Those states have raised the money to pay for the surveys which must be made in certain localities before the right of way can be located exactly. The surveys will be made by officers of the Corps of Engineers, but the money for the cost of the work will be advanced by the local interests. In this way it will be possible to acquire all of the right of way so that work on the project may begin at once when the appropriation becomes available.

Discharge measurements are being made in the Niagara River under the direction of the Corps of Engineers. This data is for use in connection with the studies being made of the lake levels and the other problems where conditions in the Niagara River are involved. The measurements will continue throughout the summer and will be compared with similar data secured ten years ago.

The Feather River Power Company has applied to the Federal Power Commission for a license covering a 60.000 hp. project in Plumas County, California. The project involves the water resources of Buck, Grizzly and Milk Creeks, tributaries of the North Fork of the Feather River. It is proposed to erect a concrete arch dam 106 feet in height in Buck Creek. This will create a reservoir with a capacity of 103.00 acre-feet. Conduits will connect Milk Creek with the reservoir. The power house will be on the East Bank of the North Fork, one-fourth mile below Buck Creek. The water from Grizzly Creek will be brought direct to the power house by conduit.

Norfolk & Western Ry. to Lease Virginian Railway

The Norfolk & Western Railway Company has applied to the Interstate Commerce Commission for authority to acquire control of the Virginian Railway Company under a lease for 1,999 years for the purpose of affording a western outlet in connection with which it is proposed to construct 53 miles of railroad from Elmore on the Virginian Ry. down the Guyandot River to Gilbert and then to a connection with the Norfolk & Western at Wharncliffe, West Virginia. Economies are to be gained through the pooling of cars and equipment, through the unification of terminals and utilization of excess power and electric locomotives of the Virginian Railway. The terms of the lease include payment by the N. & W. of the operating expenses, taxes, interest on the funded debt and 6 per cent on the Virginian Railway's preferred and common stock.

Large Water Power Project for Lake St. John Region

An extensive power development is reported to be planned at Chute au Caron in the Lake St. John region, Quebec, in connection with a project for the erection of a large aluminum plant in that region by the Aluminum Corporation of America, and the Canadian Manufacturing & Development Co., Ltd. The ultimate capacity of the Chute au Caron site which is on the Saguanay River below the site now being developed by the Duke-Price interests, is 800,000 hp. It is expected that the first installation will be 80,000 hp.

Method of Financing Housing Sought by International Congress

At the fourth congress of the International Federation of Building and Public Works, held in Paris, June 14-18, two developments in the housing situation were the acceptance by most of the nations represented of the American method of dealing with the housing shortage which existed in this country in recent years as the best method of dealing with the problem, and action on the part of the congress favoring the development of a more flexible plan of providing funds for people desiring to build their own homes. The congress proposes to make a further report on the subject of financing at its next meeting and has asked the International Chamber of Commerce for assistance in developing methods of financing home construction.

An interesting feature of the congress was the interest taken in the Associated General Contractors of America and the evidence of the international position that that organization has assumed in that its methods and conclusions are being sought for adoption in many countries.

International Road Congress to Be Held at Milan in 1926

An announcement has been made by the executive committee of the Permanent International Association of Road Congresses that the fifth congress will be in Milan, Italy, during the month of September, 1926. The invitation of the Italian Government to hold the congress in that country has been accepted.

The congress will consider two principal phases of highway work: construction and maintenance, and traffic and administration. Under Construction and maintenance concrete roads, bituminous and asphaltic roads, and standardization of tests for certain road materials will be discussed. Under traffic and administration will be considered traffic census with development and planning of towns in the interests of traffic and special roads for motor vehicles.

Paul LeGavrian, engineering chief of Ponts et Chaussees, is general secretary of the congress, and A. Mahieu, inspector-general of Ponts et Chaussees, is president.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER-WORKS ASSOCIATION, Boston, Mass.; Annual Convention in connection with trip on St. Lawrence River, Sept. 8-11, 1925.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Montreal, Que., Canada, Oct. 14-16, 1925.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Convention, St. Louis, Mo., Oct. 19-22, 1925.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Lakeland, Fla.; Annual Meeting, Des Moines, Iowa, Oct. 26-30, 1925.

The Quebec Branch, Engineering Institute of Canada, at its annual meeting elected the following officers: President, A. B. Normandin, of the Quebec Streams Commission; vice-president, A. L. DeCarteret; secretary-treasurer, Louis Beaudry.

The New England Water Works Association will hold its annual convention Sept. 8 to 11, 1925, on board the steamship *Richelieu* (of the Canadian Steamship Lines) en route from Montreal to Quebec and the Saguenay River. There will be seven sessions on the steamer for presentation of papers as well as stops at points of interest including the Thousand Islands.

The Minnesota Federation of Architectural and Engineering Societies, the Winnipeg Section of the Engineering Institute of Canada, and the other architectural and engineering societies are to meet in Winnipeg, Man., Aug. 20 and 21, this date having been set since the notice in these columns July 9, p. 79.

Personal Notes

J. W. JOHNSTON, formerly assistant general manager of the Portland Cement Association at New York, has been appointed vice president and manager of the Alabama Portland Cement Co., one of the companies of the International Cement Corporation, with headquarters at Birmingham, Ala. The Alabama Portland Cement Co. recently absorbed the Phoenix Portland Cement Co.'s southern business and has taken over its Alabama plant.

H. E. HILTS, formerly deputy engineering executive and deputy highway commissioner of the state of Pennsylvania, has been appointed assistant manager of the Virginian Portland Cement Co. with headquarters at Norfolk, Va. The Virginian Portland Cement Company is a subsidiary of the International Cement Corporation.

R. W. ARMSTRONG has been appointed division engineer of the Northeastern Division of the Kansas State Highway Commission with headquarters at Topeka. Mr. Armstrong has been division engineer of the Northwestern Division of Kansas. He was also resident engineer of Doniphan County, Kansas.

WILLIAM A. VAN DUZER, Philadelphia, Pa., has been appointed chief deputy engineering executive of the State Highway Department of Pennsylvania and as such will have direct supervision of the maintenance of roads in the state. Mr. Van Duzer has been in the engineering work of the department since 1911.

WYNKOOP KIERSTED, JR., Kansas City, Mo., acting chief engineer of the city's water department, has been made general superintendent and chief engineer of the department. Mr. Kiersted succeeds CHARLES S. FOREMAN, who resigned May 1 to become resident engineer for Smith Brothers, Inc., contractors for the Missouri River and Turkey Creek tunnels of the new waterworks system. T. D. SAMUEL, JR., was promoted from acting first assistant to first assistant engineer, and A. H. ZEITZ, from draftsman to chief draftsman in the engineering division.

J. P. GREENWOOD, who has been consulting engineer of the State Board of Control of Texas at Austin, Texas, for nearly four years, will be connected with the McClave-Brooks Co. of Scranton, Pa., as district manager of this company's Chicago office.

THOMPSON & BUTLER, consulting engineers, San Francisco, Calif., announce the formation of a partnership for general engineering practice. R. A. THOMPSON has been chief engineer of the railroad commissions of Texas and California, and a member of the engineering board of the Interstate Commerce Commission, in charge of railroad valuation in the Pacific district. H. G. BUTLER was formerly chief engineer of the California railroad commission and power administrator for the state of California.

W. C. KLAPPROTH, formerly of Oshkosh, Wis., has opened an architectural and engineering office at Oshkosh.

HARVEY O. OLESON, formerly superintendent of city bridges and buildings, Oshkosh, Wis., has been appointed building inspector for the city to succeed WILLIAM HOPPE, deceased.

DR. RICHARD T. ELY has resigned as professor of economics at the University of Wisconsin after 33 years of service and will join the faculty of Northwestern University as director of the Institute for Research in Land Economics and Public Utilities, which he founded five years ago. In recognition to his important service to the University of Wisconsin, the Regents, upon accepting his resignation, voted him the title of honorary professor of economics, so that he may continue to be a member of the faculty in an honorary capacity. Born in 1854, Dr. Ely received his degrees from Columbia University in 1876 and from Heidelberg University in 1879. His first teaching was on the faculty at Johns Hopkins University from 1881 to 1892. He went to the University of Wisconsin as professor of economics in 1892 and was one of the men who helped to build up not only the department of economics but the Wisconsin graduate school as well.

BYRON P. LYONS has been appointed chief engineer of the Red Rock Creek Irrigation District, Lassen County, California; he has been working on the reconstruction of the Yosemite Valley R.R., which is being done above the Exchequer reservoir by the Merced Irrigation District.

E. G. DUNCAN has been appointed district roads engineer for the Maryland State Roads Commission, succeeding the late GEORGE H. PARKER. Since the death of Mr. Parker Mr. Duncan has been acting in this capacity. His district includes Prince George's, St. Mary's, Charles and Calvert counties and parts of Anne Arundel and Montgomery counties. His headquarters will be at Upper Marlboro, Md.

GIBB GILCHRIST, Dallas, Texas, formerly state highway engineer of Texas, has acquired an interest in and become a partner of the Nagle, Witt, Rollins Engineering Co., whose offices are in the Santa Fé Building, Dallas.

WARREN ROBERTS has been appointed county engineer of Chariton County, Missouri, succeeding the late JOSEPH BROADDUS; and will have headquarters at Chillicothe, Mo.

H. J. KUELLING, engineer of design of the Wisconsin State Highway Commission, has resigned and opened an office in Milwaukee as consultant on municipal engineering work; he was formerly located in Milwaukee as county highway commissioner from the time of his graduation from the University of Wisconsin in 1911 to 1917. From 1917 to January, 1925, he was construction engineer for the Wisconsin Highway Commission, and since then its design engineer.

C. I. FELPS has been appointed engineer of construction for the Kansas State Highway Commission. Mr. Felps is a graduate of the engineering department of the Kansas Agricultural College. He served as the first bridge engineer for the Kansas Highway Commission and after returning from the war served as division engineer and assistant state highway engineer. For the past two years he has been construction engineer for the Maxwell Construction Co. of Columbus, Kansas.

I. E. TAYLOR has been appointed division engineer of the North Central Division of the Kansas State Highway Commission with headquarters at Beloit. Mr. Taylor is a graduate of the engineering department of the Kansas State Agricultural College and has served as county engineer of Pottawatomie County, Kansas, and also of Mitchell County.

H. D. BARNES has been appointed division engineer of the Southeastern Division of the Kansas State Highway Commission. Mr. Barnes has been county engineer of Butler County, Kansas.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Construction Equipment—Past and Present

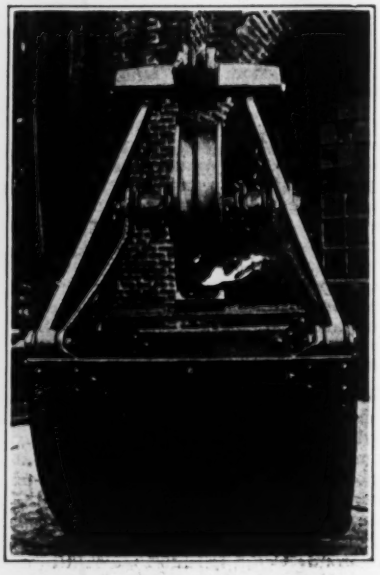
A Series of Historical Sketches of the Origin and Development of Machines for Contractors and Engineers

VII—Automatic Buckets

(Concluded from last week)

THE pioneer bucket of Ephraim Morris, patented in 1848, as noted in Part I of this article last week, used a power wheel closing mechanism. Although there have been some distinct departures from this type of closing mechanism, it is still used on many modern buckets, the present designs differing from Morris' original idea only as regards refinements.

Refinements in Design—Among the refinements in design that have been incorporated in present power wheel buckets is the grooved axle now used on practically all buckets of this type. This construction permits the turns of the power closing cable or chain to lie side by side instead of on top of each other, thus keeping the effective hub diameter constant during closing. A different device, however, for making the closing power even and constant, is used on the Hayward clamshell bucket and consists of a special type power closing chain. This power chain, in its



Early Clamshell of Hayward Co.

simplest form, consists of two bottom strands and one top stand. The bottom strands make the first wraps on the power wheel hub and the top strands the second wrap which lies in between the wraps of the bottom strands. In this way, no strand wraps upon itself.

The top ends of some power closing cables are fastened to equalizer yokes

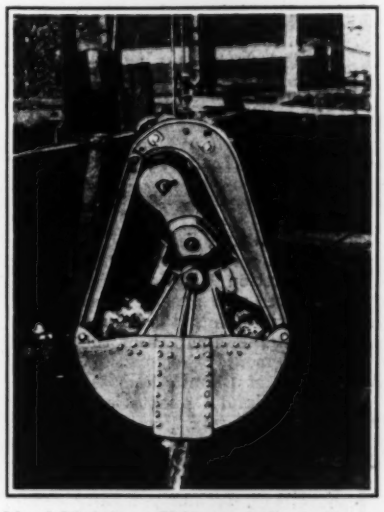
Sheave-type Bucket of McMyler-Interstate Co.; note counterweights under the lower sheaves

as introduced about 1905 by Mead-Morrison. These yokes divide the stresses equally between both cables. Numerous devices have been tried to eliminate shocks due to impact received during service, notably the spring shock absorbers placed on the power closing cables of the buckets manufactured by Industrial Works. A refinement found on the Blaw-Knox bucket is the mounting of the power wheel on a shaft of its own set above the main hinge pin. This device aims to open the bucket wider and to keep the wheel itself out of the material being handled. Provisions are made on several buckets to add counterweights between the spokes of the wheels when heavy digging is encountered, but such condition are more generally met by using another type of closing mechanism.

Sheave Type of Closing Mechanism—As the field for automatic buckets widened to include heavy excavating, more powerful closing actions were required. By sacrificing speed, such an action could be secured by replacing the bull wheel with movable sheaves, and by placing stationary sheaves in the head of the bucket. This closing motion, known as the sheave or block-and-tackle type, will develop a closing ratio of 10:1. The power wheel bucket is made to develop an 8.1 closing ratio by means of multiple reeving of chains or cable over sheaves attached to the head of the bucket. The available space on the inside of the bucket is usually the only condition governing the number of sheaves that can be used. This type of closing mechanism was introduced in the early nineties and is still used.

Lever-Arm Closing Mechanism—The sheave-closing mechanism is suitable for digging compact material, but a combination of this type with the lever arm produces a greater mechanical advantage and exerts a correspondingly greater force. The lower blocks in this latter type of closing mechanism are attached to the end of a lever, instead of being placed on the main hinge. The present lever-arm bucket also embodies certain construction features of an early bucket known as the "grasshopper" type which consisted of two bowls that were closed with two levers. The modern lever-arm bucket has omitted one of the arms and instead has connected the rope from the sheave at the end of the arm to the head piece sheave.

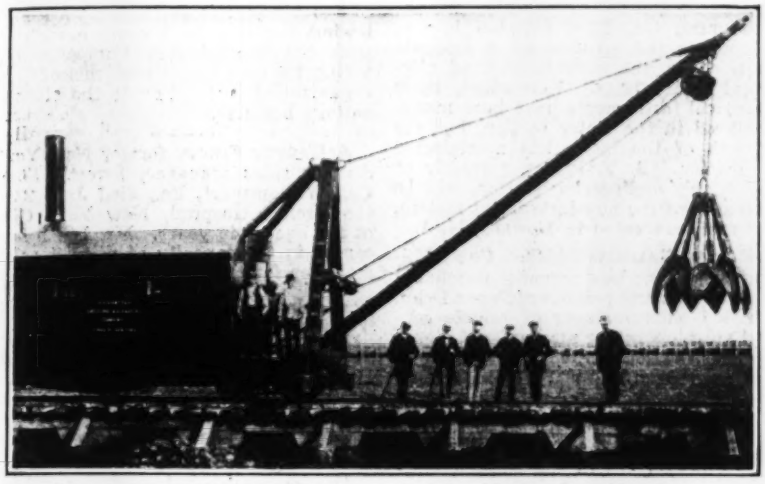
In the introduction of the principle of the lever-arm bucket the G. H. Williams Co. was a pioneer. The lever arm bucket requires a smaller number of sheaves than does the block and tackle type and can exert a more effective closing power as a result of the long travel of the sheaves in the lever arm. Blaw-Knox Co. uses this type of closing mechanism on its clamshells that are designed for heavy digging require-



Mead-Morrison Universal Grab Lever-Arm Bucket with Counterweights

ments. A recent refinement in the construction of lever-arm buckets made by the Mead-Morrison Mfg. Co., consists of a provision for changing the closing power by different reevings of the cable.

Although both the power wheel and block and tackle closing mechanisms are used on both orange peel and clamshell buckets, the lever-arm has, so far, found use only on the clamshell bucket, with the one exception of the Keisler bucket of Chicago. The closing method used on this bucket is a modification of the old grasshopper type.

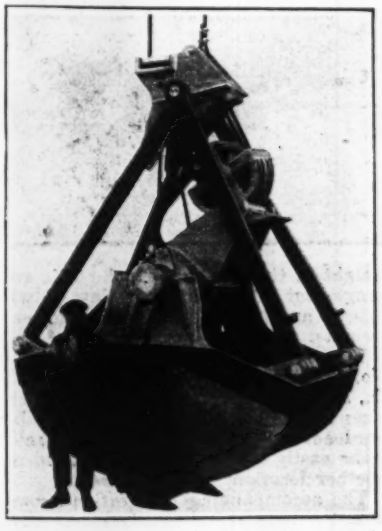


First Orange-Peel Bucket Built by Johnson Mfg. Co. in 1886

Orange Peel Buckets

The oldest types of clamshell buckets, exemplified by the Morris mud scoop, used a round shaped bowl which permitted a rapid discharge. The ore-type or flat bottomed bowl was developed about 1908 for handling sand and for excavating. This shape makes for better digging but less speedy discharge.

The orange peel, introducing a new principle in the use of a multiple-blade in place of the two-blade bucket previously employed, is better called a departure than a development from the bucket used in Morris' mud scoop. In the first place, the two types are comparable only so far as the closing method is concerned and even that was of the sheave type in the first orange peel, although soon changed to the power wheel type. Secondly, the orange peel was being developed coincident with the development of the clamshell rather than subsequent to it. While there is no manufacturing concern of the present day that truly can be called the originator of the clamshell, the orange-peel bucket has been associated continuously with one concern, the predecessor of which made the first orange peel about 1886, a bucket designed to load 2 cu.yd., and operating on a boom that was swung automatically. This company, the Hayward Co., is a direct descendant of the old Johnson Mfg. Co., formed when Dr. Johnson, the inventor of the multi-blade bucket, and John H. Hayward brought out their first bucket.



Modern 5-Yd. Blaw-Knox Lever-Arm Bucket

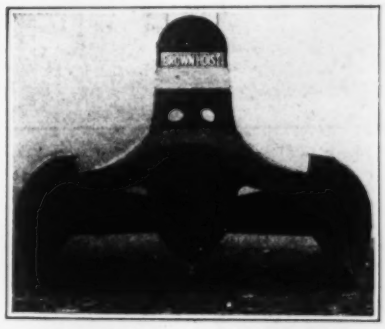
A Six-Blade Bucket—The story of the conception and development of the early orange-peel bucket is best told in the words of Judson Hayward, son of John H. Hayward:

"Dr. Johnson and my father worked out the details of the first bucket in a small workshop on Staten Island. The first model I can remember well was made of shiny brass and looked more like a golden octopus than anything I can think of. It had twelve blades (soon reduced to six) and its digestive tract was constructed of lattice bars and sheaves, over which the closing line ran. Boxes filled with sand, coal, dirt and ashes lined the room and were used for testing. I was very young then and never passed the door of this room without wondering what it was all about."

The Johnson Mfg. Co. was the outgrowth of these experiments and associations. Shortly after the formation of the company, John H. Hayward developed a four-blade and later a three-blade bucket, instead of the six-blade device. The three-blade bucket was developed for use principally as a rock grapple as shown in one of the illustrations in Part I of this article. He also substituted the power wheel closing mechanism in place of the block-and-tackle type. The orange-peel bucket has a powerful digging purchase and is heavier capacity for capacity than a clamshell—a 1-yd. clamshell weighing about 3,000 lb., while a 1-yd. orange-peel will weigh from 4,200 to 5,400 lb. Orange-peel buckets are built in a wide range of sizes. The smallest clamshell is a ½-yd. bucket, while special "dwarf" orange-peels for removing material from within the constricted space of casings for foundation piling, are built to carry as little as 100 cu.in. of material. In contrast, both types of bucket are built in sizes capable of handling 15 to 20 tons of material. Several manufacturing companies of the present day make an orange-peel bucket besides their several models of clamshells.

Construction Features

In common with changes in closing methods made necessary by more varied and exacting requirements, there have been other developments in the design of automatic buckets. The first buckets were light in weight, often using a single plate thickness for the cutting edges of the buckets. Practically all present-day buckets are reinforced on all edges with heavy steel strips, in some cases of alloy steel casting construction. Cutting edges and teeth of alloy steels are becoming common equipment where rough and hard digging conditions are encountered. Manganese is the most widely used alloy metal. The use of manganese steel has also been extended to such wearing parts as sheaves, bushings and pins.



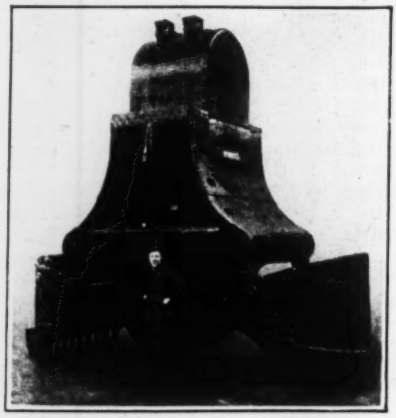
Slide Bar Bucket Made by Brown Hoisting Machinery Co.

Bucket Designed for Combined Digging and Scraping Action (Industrial Works)

Although wrought and cast iron were among the first materials used, electric steel castings are becoming the rule rather than the exception. An example of this tendency is illustrated by the Owen bucket in which one piece steel castings are used for the crosshead, closing blocks, hinges and arm brackets.

Ease of renewal of worn out parts has formed another line of development. Cutting edges and bushings can invariably be replaced in a simple manner. Mead-Morrison features a bucket, known as their Universal grab, in which the shell is bolted to the upper portion of the bucket so that it may be renewed in the field. Provisions are made in not a few buckets to widen their scope of adaptability by using removable counterweights placed in cast recesses in either the bull wheel or lever arm. One of the latest developments is the use of pressure lubrication systems on several buckets.

Hayward Dwarf Orange-Peel Buckets on New York Subway Construction



Link Type Bucket Manufactured by Brown Hoisting Machinery Co.

In addition to buckets in the two categories of clamshell and orange peel, with their several different types of closing motions, there are several buckets that depart radically from these designs. Notable among these are the buckets manufactured by the Brown Hoisting Machinery Co. Although its first bucket, built in 1894, was of the single-rope clamshell type, the company later patented a bucket using what is called a slide-bar mechanism. This type of bucket was followed in 1918 by a link type bucket. Both these buckets are built in very large sizes especially for ore-handling purposes.

The Brown company also brought out a bucket in 1897 embodying an electric motor placed in the bucket itself. There are several similar electrically operated buckets available at the present time, but their use is not widespread.

Automatic buckets have developed in both directions from a capacity of about ½ cu.yd., as used in the Morris mud scoop of 75 years ago. From the small orange-peel bucket holding less than 1 cu.ft. of material, used to sink 12-in. circular pile casings for New York's subways, to the ponderous ore-handling buckets of the Great Lakes region that pick up 400 cu.ft. of ore at each bite, represents a picture of the development in size of automatic buckets. From buckets that could handle only coal and other loose material, the automatic bucket has evolved into a machine that exerts a powerful digging action.

(Next Article: Trench Excavators)

Business Notes

WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., announces the creation of a separate section for the manufacture of electrical instruments. Heretofore, these electrical instruments have been manufactured in the meter section, but the growth of the latter has necessitated a division. R. T. Pierce, formerly of the supply engineering section, will be manager of the new instrument section, with offices located in Newark, N. J.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis., has recently purchased the business and patents of Payne Dean, Limited, manufacturer of remote control valve operating mechanisms, signal systems, switchboards, load indicators, etc. Mr. Dean and many of his associates are now connected with the Cutler-Hammer Mfg. Co.

CLAPP RILEY & HALL EQUIPMENT CO., Chicago, enters the eastern market with the new organization recently formed to operate in Pittsburgh, under the name of Beck, Riley & Hall Equipment Company. The new company will have offices in the Union Trust Building, and will maintain a plant at Neville Island, near Pittsburgh, for the rebuilding of used construction machinery. John G. Beck, of Beck & Babb has been appointed president of the new company.

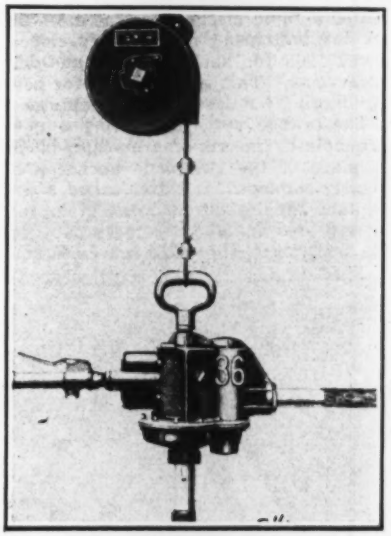
CHARLES EVERETT GILSON, formerly battery engineer of the Eagle-Picher Company, Chicago, died July 4 at the Evanston, Ill., hospital. Mr. Gilson was born at Fitchburg, Mass., in 1891. He graduated in 1914 from the chemical engineering department of Carnegie Technical Institute and began his business life with the Pittsburgh Plate Glass Company. He was in the United States Air Service during the war. Following the war he became associated with the Eagle-Picher Company, devoting his time to the problems of that organization in relation to the storage battery business.

J. HARVEY FINCH, former New York district sales manager, Sweet's Steel Co., Williamsport, Pa., died July 2 in the French Hospital, New York City at the age of 46 years. Mr. Finch had served in the capacity of district sales manager for the past ten years.

Equipment and Materials

Balancer for Pneumatic Tools Without Counterweights

A new mechanical device for suspending, balancing or lifting pneumatic or electric portable tools is being manufactured by the Chicago Pneumatic Tool Co., New York City. It is called the Pedwyn balancer and is intended to take the place of the usual method of counter balancing by means of an overhead sheave, on which a cable or rope is placed, with weights fastened to the other end that counterbalance the weight of the suspended tool. This arrangement is prohibited by law unless guards are placed around the counterweights.



This balancer is made in two sizes. No. 1 has a capacity of from 10 to 50 lb., and No. 2 from 50 to 100 lb. Both sizes are adjustable for any intermediate load within their ranges. It is said to be easily removed and reinstalled in another location if occasion requires.

The accompanying illustration shows how the balancer is constructed. The cable that holds the tool is reeled in the drum and the tool is prevented from falling by the ratchet.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

St. Louis Building Costs and Those for All U. S. Compared

Trends Identical — Prices Slightly Firmer In Specific District Than For Nation As a Whole

Index numbers showing wholesale prices of all commodities, prices of building materials, construction cost for the country generally and building costs for the St. Louis industrial district particularly, are compared in the accompanying chart. The building index number for St. Louis is computed by the Fruin-Colnon Contracting Co. of that city. This number is based upon actual and estimated costs of materials and labor on a typical industrial plant composed of five buildings of various types and materials, constructed in St. Louis.

The *E. N.-R.* Construction Cost Index Number gives a picture of the situation as applied to the country as a whole. It is based upon the price movements in such basic elements as steel, lumber, cement and labor, which are usually nation-wide in scope. Other factors, such as brick, sand, gravel, etc., are subject to fluctuations of a purely local nature.

On July 1, 1925

E. N.-R. Construction Cost Index Number 204.60
E. N.-R. Construction Volume Index Number 214

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month

It will be seen that from the early part of last year to December, 1924 the downward trend in cost for the nation as a whole, was much more pronounced than that in the St. Louis district.

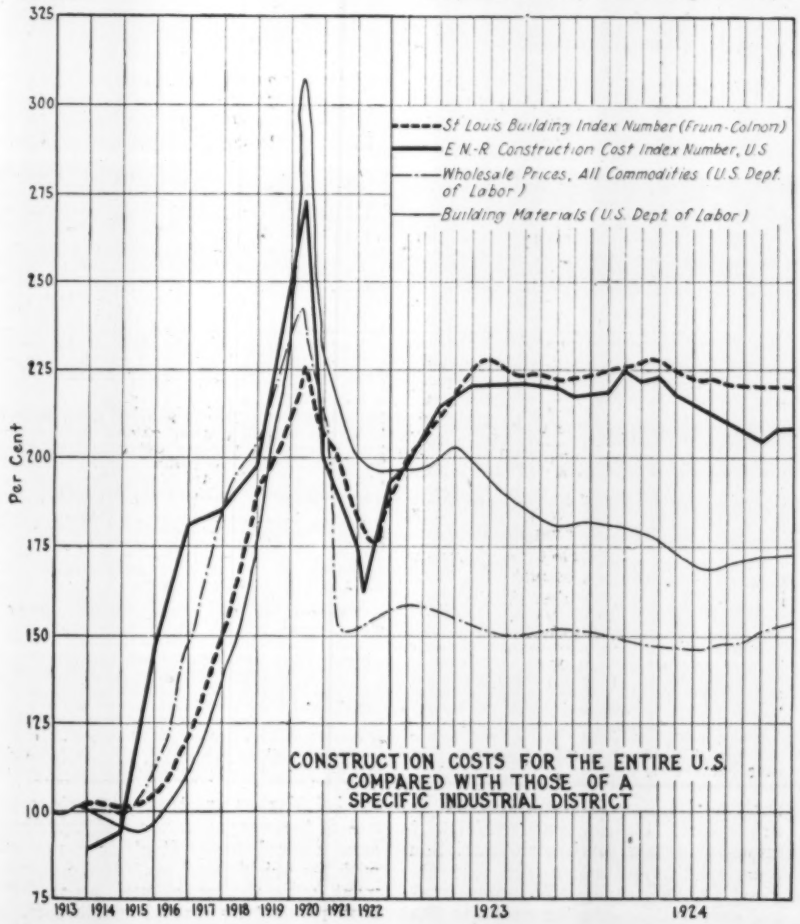
This national decline, aside from being induced by lower prices for steel and lumber, was also accompanied by a downward trend in such materials as pig iron, scrap, c.-i. pipe, rivets, wire nails, steel sheets, steel pipe, light rails, ship spikes, railroad spikes, track bolts, section angle bars, sewer pipe, brick, drain tile, hollow tile, railroad ties, wood paving blocks, sand, gravel, crushed stone, paving stone, lime, natural cement, asphalt, red and white lead, lath, rope and explosives.

At the same time, the building materials market in St. Louis registered a rise in sand, gravel, natural cement, lime, hollow tile, reinforcing bars and lumber. Advances also occurred in materials not directly related to building construction, such as standard rails, track bolts, railroad ties, section angle bars, road oils, asphalt, wood blocks, clay drain tile and rope.

In December, 1924, most of these materials began to rise throughout the entire country, bringing the two curves nearer together.

The wholesale price index is prepared by the U. S. Department of Labor through the Bureau of Labor Statistics and includes 404 commodities or price series, including farm products, foods, cloths and clothing, fuel and lighting, metals and metal products, building materials, chemicals and drugs, house-furnishing goods and miscellaneous items.

With the exception of building materials, wholesale prices in the past three years did not rise much above the low point reached in the depression of 1921.



This Week's Contracts—Week Ago—Same Week Last Year

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks.

Minimum costs observed are: $15,000 for water works and excavations, $25,000 for other public works, $40,000 for industrial and $150,000 for commercial buildings.

MONEY VALUE OF CONTRACTS LET—ENTIRE U. S.

Week Ending	Public Work	Private Work	Total Contracts
July 23, 1925	$18,427,000	$25,703,000	$44,130,000
July 16, 1925	32,291,000	31,332,000	63,623,000
July 24, 1924	31,925,000	16,069,000	47,994,000
Heaviest Week			
1924, May 8	26,370,000	38,829,000	65,199,000
1925, Apr. 2	43,603,000	27,633,000	71,236,000
Jan. 1 to Date			
1925	584,645,000	733,548,000	1,318,193,000
1924	568,150,000	604,174,000	1,172,324,000

Dispute Between Bricklayers and Plasterers Deadlocked

The jurisdictional dispute raging at present between the Bricklayers, Masons and Plasterers' International Union and the Operative Plasterers and Cement Finishers' International Association, threatens to seriously retard a national construction program that up to July 1 was 10 per cent ahead of the same period in the record year 1924.

The bricklayers refuse to arbitrate

(*Continued on p. 164*)

Weekly Construction Market

WITH the first month of the last half of 1925 almost gone, a comparison of present business conditions with those of a year ago reveals a very favorable situation, particularly with regard to construction and allied industries.

The upward trend in construction is largely in the direction of commercial buildings and public projects such as sewers and Government work.

In the major building materials the price trend is not sharply downward and there is heavier demand and production than at this time last year in steel, lumber, cement, paving brick, etc. Common brick, however, shows a slightly lessened activity in new orders, compared with a year ago.

Improvement in demand over this period last year, also extends to markets not related to construction, such as non-ferrous metals, leather and dry goods. Exports of manufactures are greater than a year ago.

Revenue freight loadings, Jan. 1 to date, are considerably ahead of the corresponding period in any year since 1920. The heavy volume of freight traffic is supported by record bank debits; the two together indicating the sustained buying and consuming power of the public.

Aside from the jurisdictional dispute existing between bricklayers and plasterers in New York, Chicago, Washington and Detroit and a strike of electrical workers in Boston, the building labor situation is fairly tranquil compared with other years.

Brickyard labor is scarce in the New York district but without perceptible effect upon prices. In Seattle the unemployment situation is considerably less acute. About half the lumber camps have resumed operations. The hearing on increased log tariffs, announced by four trans-continental railroads, has been postponed until July 31. Foreign steel entering this country through Texas ports is sufficiently small in quantity to prevent any serious disturbance of the price structure. Fabricating shops in the Dallas district are not depending on the imported material.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.90	$4.00	$3.10	$3.35	$3.07½	$3.30	$3.35	$4.25
Structural rivets, 100 lb.	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.40	—2.80	3.00	3.25	3.62½	3.35	3.25	2.30
Steel pipe, black, 3½ to 6 in. lap, discount	48%	53.2%	—53.6%	59½%	54.25%	36%	39.2@51%	50%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@51.60	54.00	54.00	48.20@50.20	53.00	62.00	52.00	53.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.40	2.05	2.20	2.42	2.84	2.52	2.65	1.80
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	1.90@2.25	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd.	1.00	1.40	2.00	1.90@2.25	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.00	2.83	1.90@2.25	1.75	2.50	2.15	3.00	1.90
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	59.00	34.00	+58.50	45.00@55.00	38.75	36.25	27.00	23.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	—18.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl.	2.50@2.75	1.45	1.85	1.35	1.35	2.70	1.60	2.80	9.50
Common brick, delivered, 1,000	18@19	10.50	—11.60	12.00	13.50	12.00	15.00	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0888	.10	— 075	.....	.085	.....	.10	.12
Hollow partition tile 4x12x12, per block	.1162	0888	.10	— 075	.07	.085	.108	.10	.10
Linseed oil, raw, 5 bbl. lots, gal.	1.04	+1.12	—1.13	1.01	+1.11	1.19	1.14	1.12	1.25
Common Labor									
Common labor, union, hour	.75	.30	....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	30@.50	.75	.50@.55	.35@.50	.50	.50	.25@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93½c.; building laborers, 75c.; excavating laborers, 55c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of July 2, the next on August 6.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.03). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Dispute Between Bricklayers and Plasterers Deadlocked

(Concluded from p. 163)

because they claim that the plasterers broke the agreement of 1911 and that such a situation is not a matter for arbitration. The agreement referred to imposed certain territorial restrictions upon each organization and also provided for interchangeable union working cards. The plasterers claim that the bricklayers are trying to gain control of their organization and that they have offered to arbitrate the matter with the bricklayers' union. An agreement with the plasterers' union has been reached by several contractors.